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THE STATUE OF LIBERTY LIGHTING THE WORLD.

THE colossal statue of Liberty, which is to be placed as a pharos in New York Bay, is at last finished. It is erected to its full height in the court of the *ateliers* of MM. Gayet-Gauthier, whence it will soon be taken in three separate pieces and transported to America. It is the greatest work of this kind that has ever been accomplished. The colossal statues of Memnon are only 62 feet high; the Jupiter Olympus, by Phidias, was only 43 feet high; the Colossus of Rhodes, 130 feet; the statue of Nero, by Zenodore, about 118 feet; the statue of Arminius, on the Grotenburg, near Detmold, in Westphalia, is about 92 feet high, including the sword; and the statue of St. Charles Borromeo, by the sculptor Cerani, erected near Arona, on Lake Maggiore, measures 77 feet.

Much greater are the dimensions of the statue of Liberty, by M. Bartholdi. This statue measures 150 feet from the base to the top of the torch carried in the right hand, which is raised above the head; 115 feet from below the plinth to the diadem; 111 feet from the heel to the top of the head; the forefinger is 8 feet long and 4 feet in circumference at the second joint; the head is 14 feet high; the size of the eye is 2 feet; and the nose is 3 feet 6 inches long. It is a veritable tower in height, and contains a wooden staircase of 145 steps, leading to the head, which will hold forty persons. A light will be placed here, and there will be electric lights in the diadem. Steps are to be arranged in the uplifted arm, making it possible to climb into the torch, which is large enough to contain fifteen people. The total weight of the statue is 100,000 pounds, of which 40,000 pounds is copper and 60,000 pounds iron.

This work is remarkable, not only from an artistic point of view, but still more on account of the manner of its execution. It is made of *repousse* copper, supported by a framework of iron. The core of this frame, which was arranged by M. Eiffel, is formed of a sort of large pylon, which is attached at four points to the base of masonry which supports the statue. The envelope of copper, which constitutes the entire exterior of the statue, is held to the pylon by iron plates placed on the interior surface of the copper to prevent its getting out of shape.

A word now about the manner in which this envelope of copper was made. M. Bartholdi first made a study of the figure, measuring nearly 7 feet from the heel to the top of the head. This model was increased four times, and then after having been reviewed and remodeled by the artist, was divided into sections, which, in their turn, were increased four times. Then on a framework divided and provided with scales of numbers, the sculptors executed models of the required size in plaster. They made a rough frame having the general form of the statue; this was covered with lathing, which was covered with a coating of plaster; then the surfaces of the model were finished. This plaster model being finished, it was necessary to take an impression in wood on which the sheets of copper could be shaped with the hammer. This was the work of carpenters, who took the form of each part by means of planks cut out in silhouettes, which planks were placed close together or crossed, and in this wooden mould the workmen shaped the sheets of copper by the pressure of a lever or the blows of a mallet. The finished pieces were finally carried for mounting into the court of the *atelier*, and here were put together and fastened to the strong frame of iron referred to above. There were about three hundred of these pieces. As we have said, the statue will soon be taken apart in order to be transported to America, where it will be remounted on Bedloe's Island, in New York Bay, on a pedestal of granite 82 feet high, which is now being erected. This pedestal will be paid for by subscriptions taken up in the United States, and the statue was paid for by subscriptions taken up in France.

THE GREAT STATUE OF LIBERTY NOW READY IN PARIS FOR SHIPMENT TO NEW YORK.

It is estimated that this great Franco-American work, which is intended to commemorate the part taken by the French in the war of independence, will cost $40,000.—*L'Illustration.*

A RECENT statement in the *Archives de Medicine Militaire* shows with much force the influence upon smallpox of systematic revaccination. Previous to the year 1834 the deaths from that disease in the Prussian army had been about one hundred annually. In 1834 the order for revaccination was made very stringent, and the figures soon fell to five, nine, and three. From 1847 the number was between two and three, and since 1874 there has not been a single death from small-pox in the army.

[TRANSLATED FOR THE SCIENTIFIC AMERICAN.]

THE DEVELOPMENT OF PHOTOGRAPHIC PROCESSES.

By DR. J. SCHNAUSS.

IT is evident that man must have noticed the action of sunlight on the growth of plants and in producing changes in various vegetable colors, at a very early period. The oldest alchemists, and among them the celebrated Albertus Magnus, were aware of the fact that a solution of silver in aqua fortis (nitric acid) would "blacken the skin." After these come a series of observations in modern times, of which the best known is Scheele's discovery of the effect of light upon chloride of silver, which we may pass over cursorily here, since even Wedgwood and Davy, who made photo prints on paper, as well as Wollaston, who employed gum guaiacum in his experiments, were as far from discovering photography as the heaven is from the earth, for they possessed no means of fixing their pictures. We will therefore begin our sketch with

NICEPHORE NIEPCE.

This Frenchman was led to his investigations by some results that he obtained while experimenting in the lithographic line with a solution of asphalt in oil of lavender. He covered a polished tin plate with this solution, and then for the first time tried the experiment of exposing this sensitive film in the camera obscura, which had been discovered long before by Porta. Of course he obtained a picture by exposing the plate for hours, and then washing it repeatedly with essential oils, which dissolved away the portions that had not been exposed to the light, and had left a photographic picture in asphalt. This took place in 1826.

THE DAGUERREOTYPE.

In 1829, Daguerre joined Niepce for the purpose of instituting experiments together for the solution of this important problem. But it was only by accident, and after the death of Niepce, which occurred in 1833, that Daguerre discovered the art of photographing upon plates of silver. Of course it would never have occurred to any one to suspect that there was an *invisible* picture on an iodized plate of silver after exposure in the camera obscura, nor to render it visible by mercurial vapors, *i. e.*, to develop it, if a lucky accident had not occurred. Liebig, in his report in the *Cornhill Magazine*, calls it "Deus ex machina." The time of exposure to light was thereby shortened a hundred times. He also succeeded in rendering his pictures permanent by means of hyposulphite of soda. Fizeau subsequently employed a solution of gold. (In 1839, Herschel fixed the first positive silver pictures on paper.)

Through the influence of the celebrated astronomer Arago, in 1839, the French government awarded Daguerre an annual pension of 6,000 francs ($1,200) and the son of Niepce one of 4,000 francs ($800) for this discovery, which they had hitherto kept a secret.

TALBOTYPES OR CALOTYPES.

Daguerre's discovery would nevertheless have had but little effect in building up the present state of photography—his process has in fact long since been abandoned—but for the simultaneous experiments of Fox Talbot with photographs on paper.

At first he tried to make a chloride of silver paper by soaking the paper in a salt solution, and then in nitrate of silver solution, but this paper was not sufficiently sensitive for taking pictures in a camera, until it occurred to him to produce an invisible picture on iodide of silver paper, and

then develop it analogous to Daguerre's process. He could not, of course, use mercury, but Talbot took gallic acid, a substance that reduces silver, and mixed it with nitrate of silver and acetic acid. In this solution he laid his iodide of silver paper with its invisible—latent—picture. After some time it actually made its appearance, black in color and negative (or reversed), because the silver reduced by the gallic acid precipitated itself upon those portions of the iodide of silver that had been acted upon by light, but left the others untouched. A cardinal point in this process was an *excess of nitrate of silver solution*, which must saturate the iodide paper when exposed, to give it greater sensitiveness. The latter is to be understood as being relatively great as compared with the chloride of silver paper hitherto in use, while very far inferior to the subsequent development processes.

Talbot obtained the first negative picture, such as can be copied on other sensitive paper, by making them transparent and pressing them together in a copying frame and exposing to the sun, so that any number of copies can be made from it. This was the first step in the negative process, which afterward reached such a wonderful development.

Talbot called his original process the calotype, and patented it in England in 1841. What is better is the enemy of what is good.

ALBUMEN NEGATIVES ON GLASS.

It was soon found that the coarse texture of the paper was a disadvantage for printing through it, and a uniform transparent medium was looked for as a substratum. Such a substance was discovered by Abel Niepce a nephew of Niepce, in 1847; it was albumen, which was mixed with iodide of potassium and poured on glass plates. The beauty and strength of those negatives has not yet been surpassed; the magnificent glass stereoscopic pictures are also prepared in this way. The iodized film of albumen must first be immersed in a bath of nitrate of silver to which strong acetic acid has been added to coagulate the albumen, and this is subsequently rinsed off—two necessary precautions that necessarily diminish the sensibility of the film in an extraordinary degree. This albumen process could not be employed for taking portraits, as it was not sensitive enough.

COLLODION NEGATIVES.

When glass had once been recognized as furnishing the best support for negative pictures, there was an incessant endeavor to simplify the process and make it more sensitive by finding some better substitute for albumen. The most brilliant success attended the discovery of the use of collodion for this purpose. Until quite recently, or for nearly thirty years, this process has prevailed exclusively. It was first proposed by Bingham and Le Gray in 1850, but was first brought out in practical form a year later by Scott Archer. For the greater part it was worked with wet plates, as the calotype process was with wet paper, *i. e.*, that the collodion, mixed with an alcoholic solution of bromides and iodides in proper proportions, are spread on a plate of glass, half dried and immersed in the nitrate of silver solution, and then exposed while still wet.

The collodion process owes its great sensitiveness, as compared with its predecessors, to the omission of a large excess of acid (acetic acid), and the use of pyrogallic acid, which was then employed by Liebig in alkaline solution for absorbing oxygen in air analysis, as a developer. It is much more energetic than gallic acid. Still, in the wet process, it requires the addition of an organic acid, acetic or citric, to moderate its powerful reducing action. It is only in the dry collodion and gelatine processes, especially in the emulsion process, that all acids can be omitted, and the alkaline pyrogallic acid solution used, whereby the sensitiveness of the plate has recently been increased to the maximum point. At first sulphate of iron was employed as developer, but only for wet plates, while protoxide salts of iron made with organic acids, especially oxalic and citric, are more successfully employed in the dry process.

DRY PLATES.

The use of wet collodion plates was frequently attended with much inconvenience, so that numerous experiments were made in the use of dry ones. The first condition to be fulfilled was to completely wash off the silver solution, or else in drying it would dissolve the iodide of silver film and cover the plate with a crystalline frosting. Next the surface must be covered with a so-called preserver, which was found to consist of an indifferent, hygroscopic, organic substance. Albumen, honey, secretions of coffee (beer), and especially tannin, were found to work best. Nevertheless, all dry plates were 15 or 20 times less sensitive to light than wet plates, even if the excess of nitrate of silver, which is always necessary, were restored in developing. In 1862, Russel and Sutton recommended the use of alkaline pyrogallic acid for developing dry plates, instead of the strongly acid solution hitherto in use. The sensitiveness was, indeed, considerably increased by this change, but photo-chemists directed their efforts to mixing the bromide and iodide of silver with the collodion in the form of emulsion; so as to avoid the inconvenience of using a silver bath and to get rid of the numerous washings that it entailed. Iodide of silver proved to be unsuited to use in emulsions, bromide of silver worked far better with *alkaline development*. Sayce was the first to publish this process in 1864, and it was subsequently improved by Carey Lea and Worthley.

Another improvement upon the bromide of silver and collodion emulsion was effected by precipitating it from solution by adding water, washing, drying, and redissolving it. Although the manipulations were in general safer and simpler for the photographer, still this emulsion was far from possessing the great sensitiveness of wet plates. We are now nearing a point when the discovery should be made that marks an epoch in dry plate photography, namely, totally discarding the collodion, and substituting gelatine for it, while retaining the bromide of silver emulsion and alkaline development.

The first happy thought in this direction occurred to an English physician named Dr. Maddox. It was improved on by J. King, and finally so far perfected by Burgess and Kennett that their gelatine emulsion plates were put in the market. It will be noticed that the English have always been in the advance in this process. By using the double oxalate of iron and potash as developer, this process became considerably more certain, and at present has attained an unexpected extension and success. Recently the precipitation and washing of the emulsion practiced with collodion have been imitated with gelatine, substituting alcohol for water.

PRINTING ON PAPER.

In copying upon paper that contains chloride of silver, but two improvements have been made on the original process, described by Fox Talbot in 1839 before the Royal Society of London, namely the use of albumen and of an alkaline gold toning bath. The albumen process was discovered by Fizeau in 1848, and the alkaline gold bath, whereby photography first attained its present beauty, was invented by Waterhouse in 1859.

Although in the negative process the silver salts have also played the chief roles, they have frequently been replaced by other salts for copying and printing on paper. The expense of the silver salts and the liability to fade were inducements to seek other means, although Davanne and Girard's experiments extending over ten years go to prove that a silver print well washed and well toned (with gold) is unchangeable.

BICHROMATE PRINTS.

The principal salts employed in all the methods for dispensing with silver salts for photo-printing are the alkaline bichromates.

In 1838 Mungo Pouton first employed a solution of bichromate of potash in which he soaked the copying paper, and then exposed it under a negative, when the chromic acid was reduced by the light in the presence of organic substances to chromate of chromium, producing a brown positive on a yellow ground.

Becquerel obtained blue pictures by soaking the paper with starch paste, washing the brown picture, and then exposing it to vapors of iodine. This picture also served as mordant for various subsequent toning processes. Yet all these methods possess only a chemical interest, and none of them found its way into practical use.

Poitevin was the first to make a decisive experiment with bichromate of potash and glue or gelatine, which now serves as the basis of a large number of printing processes of the highest importance.

The processes for printing with pigments depend on the fact that the chromated gelatine with which the pigment is mixed becomes insoluble when exposed to the action of light. Photo-lithography is based on the property which non-exposed gelatine has of absorbing water, and the attraction of a layer of chromated gelatine for fatty inks wherever it has been illuminated. The photo-relief process called Woodburytype depends on the property that the non-exposed stratum has of swelling up in water, and so do the heliographic and high relief processes. By exposing a chromated film of gum or sugar under a transparent positive, and then dusting it with pigments used for enamels, a positive is obtained, because the pigment only adheres to the non-exposed portions; such a positive can be transferred to porcelain and burned in. This now forms the basis of a new and lucrative branch of the art.

We see then that the domain of photography, at first a mere art of taking portraits with the aid of the sun's rays, has grown within the short space of forty years to a colossal extent, and now has an undreamed of importance in science, art, and industry, and its limits are not yet known.—*Chemiker Zeitung.*

THE EXTRACTION OF SULPHUR.*

SULPHUR is found either in superficial deposits, the result of volcanic emanations, constituting the *solfataras*, or else at a considerable depth underground, associated with calcareous and bituminous marls, gypsum, celestite, etc., forming the sulphur mines, which are the most important sources of this material.

The principal mines are in Sicily and in continental Italy. The ore is gotten out with picks, and is transported from the mine on the backs of men. Its extraction is effected by the partial combustion of the sulphur. This causes heat enough to fuse the remaining portion, which then flows into a hollow in the ground, from which it is collected. In Sicily the sulphur is treated in a kiln, termed the *calcaroni*. It consists of a wall inclosing an inclined circular area, on which the ore is placed. The heap is covered with a layer of spent material thick enough to keep the combustion from proceeding too rapidly, and spaces are left here and there for the insertion of fagots of wood. The *calcarone* ready, the fagots are lighted, and the access of air so regulated as to avoid active combustion and too high a temperature. After the operation has been in progress a certain length of time, the operatives begin collecting the sulphur, and continue it until the ore is exhausted. In this operation considerable quantities of sulphur dioxide are produced, and in consequence of the difficulty of regulating the draught, much sulphur is wasted. Great damage is caused to the surrounding country, and any cultivation of the ground within a certain radius of the burning-places is prevented. So great is this nuisance that the government of Italy forbids "burning the ore" between the first of July and the thirty-first of December.

The *calcaroni* yield but 50 per cent. (at most 60 per cent.) of the sulphur contained in the ore, the rest serving as the fuel, and thus producing torrents of sulphur dioxide. The imperfections of this process have for a long time given rise to numerous attempts to devise a more rational and less costly method of extracting the sulphur by the employment of some other kind of fuel. Heated air, steam under pressure, superheated steam, and carbon bisulphide to dissolve the sulphur, have in turn been proposed for the purpose of obtaining the greater part of the sulphur without the production of sulphurous acid fumes.

In the first of these methods, a chamber of masonry is filled with the ore, and a current of warm gas, from a hearth fed with wood or coal, is sent into it. This prevents in great measure the production of sulphurous acid, but the action is slow, and the mass of ore is irregularly heated. A large amount of fuel is used, and the number of bands is increased, so that the economy over the old method is very small.

The use of steam seemed at first sight to offer the best solution of the problem, for its action is very simple and rapid, and the sulphur obtained of good quality. The yield is better than in the *calcarone* process, and no sulphur dioxide is produced.

But the advantages of this method are counterbalanced in great part by the extra expense of purchasing and maintaining the equipment as well as furnishing the fuel. The apparatus necessary are the boilers for heating the water, tanks to receive the ore, and other accessories. The water available for supplying the boilers is bad, rapidly forming crusts, which increase materially the cost of maintenance. Besides, the proportion of fuel used is considerable, in consequence of the large amount of steam necessary to heat the ore as well as the loss of heat due to radiation from the uncovered surfaces of boilers, tanks, etc. This process cannot be applied in all cases, for the increased yield will not compensate for the greater cost of operating.

The treatment by carbon bisulphide, though very rational *a priori*, presents inconveniences that make its use impracticable. This solvent volatilizes very rapidly, making it difficult and dangerous to work with, besides causing a considerable loss of material.

These difficulties have prevented the various processes from being used to any great extent, so that the old method of the *calcarone* is the one still generally employed.

In 1805 Thomas proposed immersing the ore in salt solutions heated to a suitable temperature. Balard, in 1867, thought the water from the salt marshes, which is rich in magnesium chloride, might answer. And finally, in 1868, Dépérais took out a patent in Italy for the extraction of sulphur by the immersion of its ores in a liquid heated 10° or 20° above its fusing point. By this means it is separated from the earthy materials associated with it. He used a solution of calcium chloride. The apparatus consisted of a spherical boiler of 2,000 liters capacity, furnished with a stopcock for drawing off the liquid sulphur, and surmounted by a vertical cylindrical part, into which, with the aid of a pulley, a basket of perforated iron, filled with the ore, can be let down upon a grate.

The apparatus is placed in a furnace, and heated directly, while the cylindrical portion is surrounded by the warm gases passing up the chimney. The basket of ore is let down into the solution of chloride of calcium heated to 130°. The sulphur melts, collects in the bottom of the boiler, and is drawn off by the stopcock and poured into moulds. When the ore is exhausted, the basket is raised and immediately immersed in water contained in another boiler heated in the same furnace. This was used to supply the place of that lost by evaporation in the first.

At that time chloride of calcium was comparatively dear, so that the patent could not be worked successfully, and was soon abandoned.

Very recently this process has been taken up by MM. De la Tour and Dubreuil, and put into practice by them with success.

Chloride of calcium is now very cheap, in consequence of the rapid development of the soda industry (the ammonia process). It can be put down at the sulphur mines in Sicily at 9 francs per 100 kilos.

The apparatus of MM. De la Tour and Dubreuil consists of two rectangular tanks, holding about 2 cubic meters each (2 m. × 1·30 m. × 0·75 m.). The bottom of the tanks is inclined 0·1. They are placed in the same furnace, and heated alternately by the same fire, which is fed with coke, lignite, or coal. The ore is placed in one of these tanks, in which is also placed a solution of calcium chloride boiling at 120°. Heat is then applied, the sulphur melts gradually, and is drawn off directly into moulds by means of a spigot.

The whole operation lasts about two hours. The end is reached when the sulphur ceases to flow. The calcium chloride solution is then drawn off into the other tank, previously charged with ore. Half of the liquid flows through a communicating tube, the rest is received in a vat built in the ground, and is raised by a pump. The gangue is washed to regain the salt which it has absorbed, and this dilute solution is used in filling the tanks as occasion demands. The heat is then directed upon the second tank, and the first is cleared and recharged. There is no interruption in the work, and the heat from the fire is all utilized. The sulphur obtained contains only 0·1 per cent. or 0·2 per cent. of impurity, whereas that obtained from the *calcaroni* contains from 2 per cent. to 3 per cent. There is left in the gangue but 4 per cent. or 5 per cent. of the sulphur originally contained in the fresh ore.

In this treatment certain ores are completely disintegrated in consequence of the fusion of the sulphur, which is then mixed with earthy matter. MM. De la Tour and Dubreuil, in order to overcome this great inconvenience, were compelled to change completely the plan of their apparatus. The new plan which they adopted is applicable to the treatment of ores of all kinds.

The tanks are built horizontal, and are divided longitudinally through the center by a gutter with inclined sides, which collects the sulphur, and from which it is drawn. On its two sides iron gratings are built vertically to keep the ore from falling into it. These gratings are made of bars of sheet iron 2 mm. thick and 25 mm. wide, placed 3 mm. apart. By this new arrangement they can treat ores of all kinds, even the fine powder formed in mining the ore. This powder is very rich, and is known in Sicily as *sterri*. It was formerly left at the mines. This *sterri* is always richer than the average of the mined ore, for in getting the ore out the rock breaks and divides along the lines of least resistance, which in this case are the veins of sulphur. On account of its friability the sulphur is reduced partially to dust, and forms a large part of the mixture.

At the Tronica mine, in the province of Caltanisetta, in Sicily, the ordinary ore gives 21 per cent. of sulphur when treated by the calcium chloride method, while the *sterro* yields 72 per cent. The average yield of the Sicily ore, treated in the *calcarone*, is from 12 per cent. to 13 per cent. In some few cases it reaches 17 per cent.

On comparative treatment the same ores yielded from 10 per cent. to 12 per cent. by the *calcarone* process, and from 19 per cent. to 23 per cent. by fusion in chloride of calcium bath.

It has been known for a long time that ores very rich in sulphur acted badly in the *calcarone*. The combustion is too rapid, and the sulphur, browned and viscous from overheating, is hard to draw off. In order to treat such ores it is necessary to mix them first with inert material when the yield is not in accordance with the primitive richness of the ore. These rich ores are, on the contrary, treated advantageously in the chloride of calcium bath.

After the treatment of a large amount of *sterri*, MM. De la Tour and Dubreuil estimated the cost of extraction of a ton of sulphur at 12 fr. 75 c. in the case of a mean yield of 33 per cent. of the weight of the ore.

The cost of treatment of one charge (about 1,000 kilos.) in their apparatus, is as follows:

35 kilos. fuel (coal mixed with lignite) at 30 fr. per ton.	1 fr.	5 c.
14 kilos. chloride of calcium, 2 per cent. carried away by gangue after washing, at 9 fr. for 100 kilos....................	1	25
Labor....................	1	25
Unforeseen, general expenses, 20 per cent.		70
Total....................	4 fr.	25 c.

Thus, in order to obtain a ton of sulphur, three charges must be worked, making the cost of extraction 12 fr. 75 c. per ton.

An operation with *sterri* requires an hour and a quarter for fusion, a quarter of an hour for drawing the sulphur, and an hour and a half for washing the gangue and letting it drain, clearing the tank, and putting the movable gratings back in place.

* Translated from a paper by M. Camille Vincent, in the *Bulletin de la Société Chemique.*—*American Chem. Journal.*

MM. De la Tour and Dubreuil have already introduced a number of their tanks in the sulphur region, principally for working up the *sterri*. There are three at the Tronica mine, in the province of Caltanisetta; two at the Grottarossa mine in the same province; two at Pernice, near Recalmuto; and two at the mine Crocca.

The method just considered presents great advantages over the older methods:

1. It allows the extraction of the greater part of the sulphur from ores of every kind, at a minimum cost for fuel.
2. The extraction is effected regularly, protected from atmospheric influences.
3. Work is carried on throughout the year, as no sulphurous acid fumes are formed.
4. It permits the treatment of the ores according to the demands of the trade.

NOTES ON THE THERMOMETER.

AT a recent meeting of the Royal Meteorological Society, the president read a paper entitled "Brief Notes on the History of Thermometers." He stated that the subject had been handled in a comprehensive manner by M. Renou a few years ago in the *Annuaire* of the French Meteorological Society, so that he should merely mention some of the leading points. The name of the actual inventor of the instrument is unknown. The earliest mention of it as an instrument, then 50 years old, was in a work by Dr. R. Fludd, published in 1638. Bacon, who died in 1636, also mentions it. The earliest thermometers were really sympiezometers, as the end of the tube was open and plunged into water, which rose or fell in the tube as the air in the bulb was expanded or contracted. Such instruments were of course affected by pressure as well as temperature, as Pascal soon discovered. However, simultaneously with such instruments, thermometers with closed tubes had been made at Florence, and some of these old instruments were shown at the Loan Collection of Scientific Apparatus at South Kensington in 1876. They are Florentine Academy collections, and in general principle of construction are identical with modern ones.

Passing on to the instrument as we now have it, Mr. Scott said that most of the improvements in construction in the earliest days of the instrument were due to Englishmen. Robert Hooke suggested the use of the freezing point; Halley, the use of the boiling point and the employment of mercury instead of spirit; and Newton was the first to mention blood heat. Fahrenheit was a German by birth, but was a *protege* of James I., and died in England. Reaumur's thermometer, in its final form, owes its origin to De Luc; while the Centigrade thermometer, almost universally attributed to Celsius, was really invented by Linnæus. Celsius' instrument had its scale the reverse way, the boiling point being 0° and the freezing point 100°.

After the reading of this paper the meeting was adjourned, in order to afford the Fellows and their friends an opportunity of inspecting the exhibition of thermometers and of instruments recently invented. This exhibition was a most interesting one, and embraced 136 exhibits. The thermometers were classified as follows: (1) Standard, (2) Maximum, (3) Minimum, (4) Combined Maximum and Minimum, (5) Metallic, (6) Self-recording, (7) Solar Radiation, (8) Sea, (9) Earth and Well, (10) Thermometers used for special purposes, (11) Thermometers with various forms of bulbs, scales, etc., and (12) Miscellaneous Thermometers. In addition to these there were also exhibited various patterns of thermometer screens, as well as several new meteorological instruments, together with drawings, photographs, etc.

SUGGESTIONS IN ARCHITECTURE.

WE give from the *Architect* (London) an elevation of a very pleasing villa erected in Branksome Park.

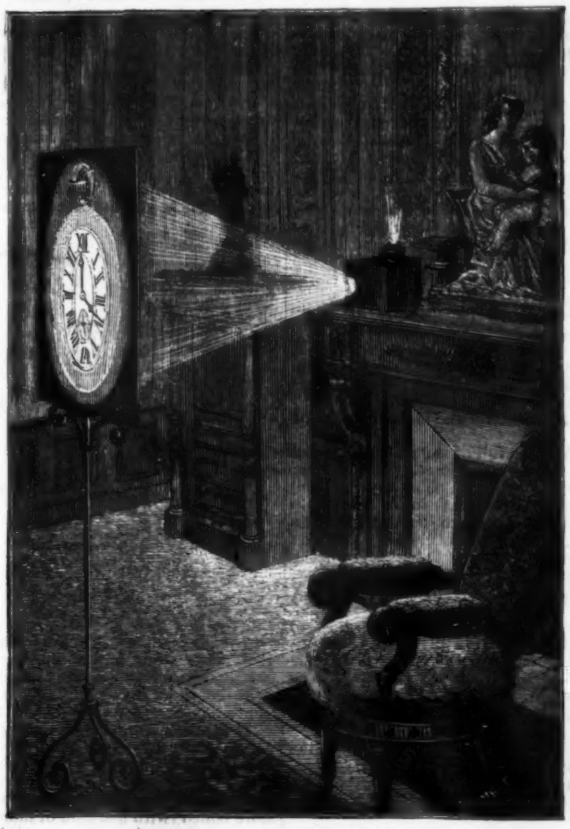
JOYEUX'S NIGHT-LAMP CLOCK.

OUR readers are assuredly acquainted with the megascope, a very interesting apparatus which serves for projecting upon a screen an image of an opaque body that happens to be placed in a proper position.

Mr. E. Joyeux has had the happy thought of constructing a megascope of small dimensions designed especially for projecting the face of a watch upon a transparent screen at night. We thus have a night-lamp that gives a certain amount of light, and a dial of large dimensions, upon which the time can be constantly seen without having recourse to a match, which does not always strike fire, and to looking for a watch, which cannot always be found on first feeling for it.

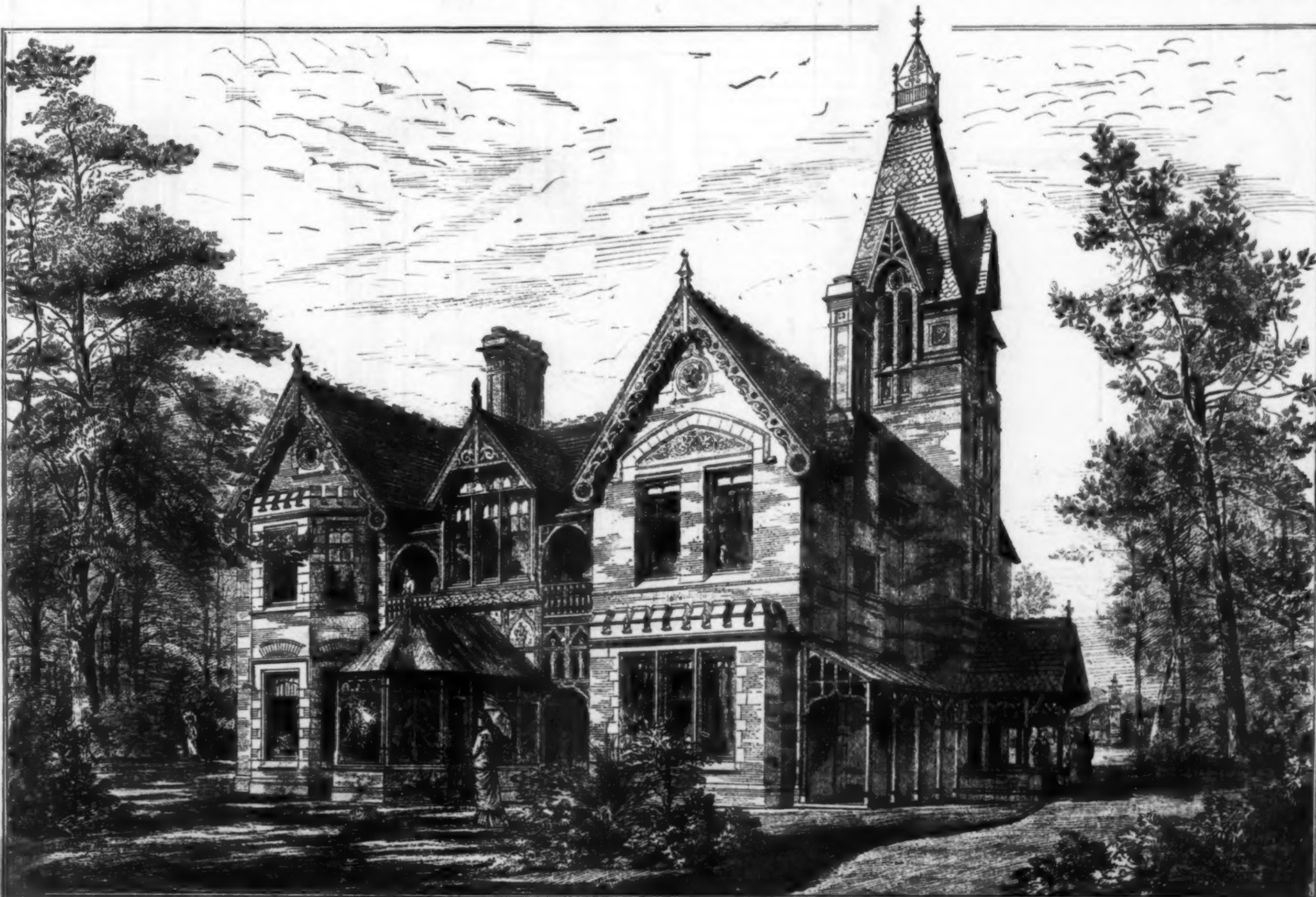
The inventor proposed to himself the following problem, which he has completely solved: Being given the flame of a small and simple oil lamp, to utilize (1) its luminous power for projecting upon a screen the enlarged image of an ordinary watch, and thus give the time at night, and (2) to utilize its calorific power for heating any sort of liquid.

The apparatus consists of a small metallic camera provided with an objective mounted in a draw-tube. The side opposite the objective opens by a hinge, and it is against the inner surface of this that the watch is fixed by means of a catch. In the interior of a camera, and a little to one side with respect to the axis of the objective, there is arranged a small oil lamp provided with a reflector for illuminating the watch. This lamp is surmounted by a smoke-plate capable of receiving a cup or other vessel proper for heating a liquid.



JOYEUX'S NIGHT-LAMP CLOCK

The lamp having been lighted and regulated, the watch is placed in position, the noon hour downward, and the apparatus is set upon a table or mantelpiece. Then a transparent screen, made of linen or tracing paper, is placed in front of the objective. After a few experiments the desired size of image may be obtained; but an effort should not be made to obtain too great an amplification, since the larger the



Pine Tower. Branksome Park. Bournemouth. Lawson & Donkin. Archts.

image the less the brightness of it. The most proper size appears to be five times the diameter of the watch, this corresponding to a distance of about 0·85 m. between the objective and the screen. The consumption of oil is insignificant, say fifty grammes per ten hours, or an expense of six centimes per night.—*La Nature.*

FORMATION OF CUPROUS ACETYLIDE.

By G. STILLINGFLEET JOHNSON, King's College, London.

HAVING been in the habit of preparing cuprous acetylide for Professor Bloxam for some years past by McLeod's method, *i. e.*, by passing the products of combustion of air in coal-gas into an ammoniacal solution of cuprous hydrate obtained by adding excess of ammonia to a solution of cuprous chloride in hydrochloric acid, it always appeared to me that the most troublesome and unsatisfactory part of the process was the production of the cuprous chloride and the large amount of cuprous chloride converted into cupric hydrate, instead of into cuprous acetylide, after the addition of the ammonia to the cuprous solution.

To avoid these difficulties, Professor Bloxam suggested to produce an ammoniacal solution of cuprous hydrate by the reducing action of glucose upon ammoniacal cupric sulphate. Acting upon this suggestion, I now employ the following apparatus, which is simple, economical, and easily worked.

The stream of air is produced by the pressure of water in the metal reservoir, A, upon the air in the glass gas-holder, B. Now, as this part of the apparatus has been found, not only by myself, but also by many others in King's College, an extremely useful arrangement for storing gases over water without danger of contamination with the gases of the atmosphere, I will first describe the manner in which it is worked.

Suppose the reservoir, A, to be full of water, B to be full of air, and the taps, C, D, and G, all closed. It is desired to fill B with a certain gas, *e. g.*, oxygen. The taps, G and C, are opened, when the water contained in A flows into B, displacing the air it contained through the tap, G. As soon as B is full of water, the tap, C, is closed. Now, on connecting G with the apparatus containing or evolving oxygen gas, and opening the tap, D, the water in B flows out through D, while oxygen is drawn into the gas-holder, B, by a kind of aspiration. When B is full, the taps, D and C, are closed, and so long as C is also closed, there is no possibility of communication of the gas in B with the atmosphere. By opening C we subject the gas in B to the pressure of the water in A, by which pressure it may be expelled with whatever rapidity we wish through the tap, G. In my apparatus the gas-holder, B, is capable of holding about 12 liters of gas.

The special advantage of this apparatus for supplying the air to be burnt in coal gas is the ease with which the rapidity of the current of air may be regulated by means of the tap, G, since oscillations of pressure are very apt to extinguish the flame.

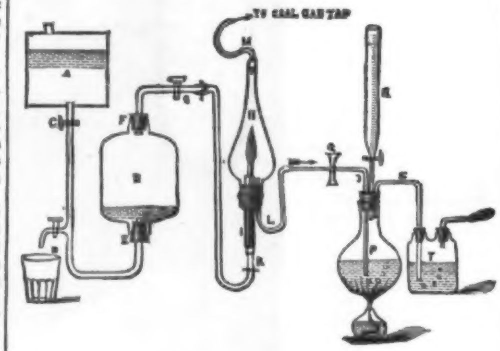
The second part of the apparatus, in which the acetylene is produced, is figured and described in Professor Bloxam's work, "Chemistry: Inorganic and Organic, with Experiments," 5th edition, p. 93. I will quote his description of the diagram:

"An adapter, H, is connected at its narrow end with the pipe, M, supplying coal-gas. The wider opening is closed by a bung with two holes, one of which receives a piece of brass tube, I, about three-quarters of an inch wide and 7 inches long, and in the other is inserted a glass tube, L, which conducts the gas to the absorbing apparatus. The lower opening of the brass tube, I, is closed with a cork, through which passes the glass tube, K, connected with a gas-holder containing atmospheric air."

The air in H being expelled by coal-gas, which is ignited at the orifice of the brass tube, I, the tube, K, delivering air from the gas-holder, B, is thrust up through the tube, I, into H, where the jet of air remains burning in the coal-gas.

It now only remains to describe the *Absorbing Apparatus* intended to fix the acetylene as cuprous acetylide.

The tube, L, is now delivering coal-gas, charged more or less with acetylene, one of the products of the combustion going on in H. This tube, L, is connected by rubber tubing with another glass tube, O, passing nearly to the bottom of the flask, P, through one of three holes in its cork. A strong screw clip, Q, closes the connector on O from the atmosphere. The flask, P, contains at first a strongly ammoniacal solution of cupric sulphate. The clip, Q, being closed, the contents of the flask, P, are raised to the boiling point, the ammonia evolved being absorbed by water in the bottle, T, into which it is conducted by the tube, S, provided with a Bunsen's valve with a *longitudinal* slit, to prevent regurgitation. When the ammoniacal cupric solution quite boils, a solution of glucose is dropped in from the burette, R, and the boiling continued till the solution is quite colorless. The clip, Q is then opened, and the connector slipped on to L, when the coal-gas and acetylene enter the flask, and the cuprous acetylide is precipitated as usual.



Should any air accidentally enter the flask, P, at any time before the copper is completely converted into acetylide, the clip, Q, may be again closed, the contents of the flask once more boiled (with addition of more glucose from the burette if necessary), and the blue cupric hydrate again reduced to the cuprous condition, after which Q is opened and the acetylene allowed to enter as before.

If the pressure of the coal-gas be insufficient to force it through the Bunsen's valve, the tube, S, may be removed, and a simple glass tube, bent once at right angles, substituted, at the orifice of which the escaping gas may be burned.

By the adoption of the above method, the necessity for first making a quantity of cuprous chloride is quite obviated, and the *whole of the copper* introduced into the flask, P, may with certainty be converted into cuprous acetylide without the trouble of removing it, introducing fresh charges, etc.; the reduction of any cupric hydrate accidentally produced being readily effected, as I have described, without disturbing the apparatus in any way.—*Chemical Journal.*

PUPLUS' DYNAMOMETER.

IT is indispensable that every manufacturer, who is mindful of his interests, shall ascertain the economical conditions under which the work of the steam engines that he employs is being produced; and, in order to facilitate his means of control, he should have at his disposal an apparatus that requires no manipulation, and the continuous indications of which are registered automatically.

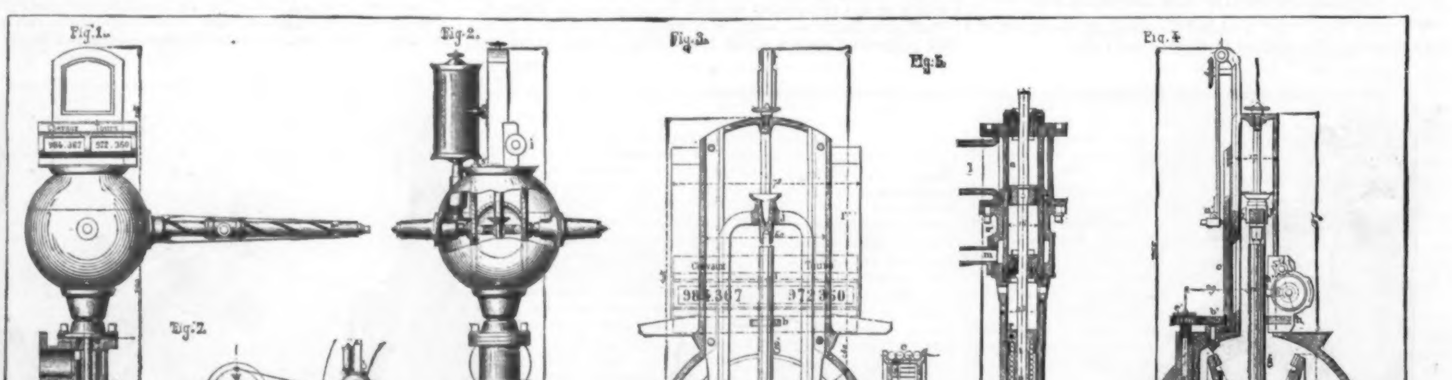
This was the object that Mr. Puplus had in view when he devised the dynamometer represented in the accompanying engraving. This apparatus, when permanently applied to a motor, uninterruptedly registers upon the dial of a counter the effective work in horse power; so that, knowing the quantity of coal consumed in a given time, on dividing it by the number indicated upon the counter we obtain the consumption per horse.

When resistances due to compression occur in the cylinder, the counter accurately subtracts the dead stress from the effective ones that are registered in measure as they take place. The operation is performed, then, upon figures that give with accuracy the effective work of the engine during any period whatever.

Although this dynamometer is based upon an already known application, it differs in its construction from all similar apparatus. Alongside of the general views in the engraving are given all the details of its construction. A small piston, *a*, adjusted in a tube and mounted with a tension spring, *b*, is put in communication, by tubes, *l* and *m*, with the two extremities of the cylinder of the engine. It carries a rod, *t*, which is prolonged in order to give a wheel, *f*, a rectilinear motion proportional to the effective tension of the steam. This wheel is interposed between two differential disks, *ee*, against which its contact is secured by means of springs mounted upon the axles, E. The disks, *e*, gear at their circumference with a pinion, *d*, which communicates an alternating circular motion to them, corresponding to and like that of the engine.

As a result of these two simultaneous motions, the wheel, *f*, has a circumferential velocity that represents the product of the pressure by the distance traveled, and consequently proportional to the work of the engine. So long as the latter is doing effective work, such work is added up by the wheel *f*, which is revolving in the same direction; for every time there is a change in the direction of the piston the wheel passes on the other side of the center of the differential disks. But, during a period of compression, as such a motion does not occur, the wheel revolves in an opposite direction, and subtracts the ineffective work from the figure that has previously been indicated upon the counter. In all cases the circumferential velocity of the wheel remains always proportional to the work of the steam upon the piston of the engine.

Such is the principle of this dynamometer, whose perfect operation is secured by the exceeding sensitiveness of the mechanism. The double acting spring of the dynamometer tube always acts in the direction of the tension. Upon the rod of the prolonged piston, *t*, there is fixed a long socket, *n*, and at the bottom of this there is a second one, *o*, attach-



FIGS. 1 AND 2.—General View. FIG. 3.—Longitudinal Section. FIG. 4.—Transverse Section. FIG. 5.—Section of the lower part of the Dynamometer. FIG. 6.—Helicoidal Rod for directly actuating the apparatus. FIGS. 7 AND 9.—Actuated by an endless cord. FIGS. 8 AND 10.—Actuated by a helicoidal rod.

PUPLUS' DYNAMOMETER AS APPLIED TO AN ORDINARY HORIZONTAL ENGINE.

ed to the lower part of the spring and provided with a stop, P, that slides in a slot in the tube, Q. When the effective pressure upon the piston, *a*, is null, the stop, P, occupies the upper part of the slot, while the ring, *r*, connected with the last spiral of the spring, rests, through the shoulder, *s*, against the socket, *n*. In this position the spring is neutral. It is tightened by the socket, *n*, which thrusts the ring, *r*, when the piston, *a*, rises; but if the latter descends, the extremity, *u*, of the socket, *n*, pushes against *o*, and causes the spring to elongate downward, in taking its fixed point upon the shoulder, *s*.

When the tension of the spring has become slightly modified through long working, it is only necessary to revolve the socket, *o*, in order to put it and the ring, *r*, in contact again with the socket, *n*, in the neutral position of the spring. In order to regulate the power of the latter, Mr. Puplus has devised an arrangement which consists in the use of a long nut, *v*, which is screwed up in such a way as to render a certain number of the spirals immovable. It is certain, in fact, that by causing the active length of the screw to vary to a perceptible degree we increase or diminish its power. Finally, the contours of the regulating pieces and the interior of the tube, Q, are channeled in such a way that, after taking off this part for regulating, the four pieces are invariably fixed by the tube's mounting.

As may be seen in Fig. 3, the wheel, *f*, is placed in an independent case, *j*, which is connected with the piston rod by a free joint, *k*. Its axis revolves upon two pivots in oil cups, and forms, above, a long pinion, *g*, which gives motion to the first wheel to the right of the counter. Between the latter and the decimal wheel there is still a diminution in velocity from 60 to 70, obtained by an endless screw, thus reducing to a few grammes the stress to be transmitted.

Moreover, as the wheel, *f*, is held at the two extremities of the same diameter by the two differential disks, it revolves without vibration, and its axis is submitted to no torsional stress. And so, too, the behavior of the differential disks has no influence upon its sensitiveness. Finally, in cases where the motion of this wheel is rapid, it is provided at its circumference with small cylinders that revolve upon pivots and render friction almost null.

The counter, *i*, is formed of a series of spur and diagonal gearings. At one side it gives the work in horse power, and at the other the number of revolutions of the engine. In the first place, a spur-wheel, *h*, keyed to a vertical axle provided with pivots, gears with the long pinion, *g*, and carries toward its center an endless screw that actuates a second gearing placed upon the decimal axle of the work counter. As for the apparatus that registers the number of revolutions, this is actuated by a small lever placed upon the axle of the decimal wheel. An index, *h'*, fixed upon the case of the wheel, *f*, lifts this lever at every revolution and causes it to act, through a tappet, upon a triangular toothed wheel, and thus to communicate motion to the decimal wheels.

Mr. Puplus has likewise provided the apparatus with a mechanism for taking diagrams. By consulting Fig. 4 it will be seen that the differential disk, *e*, carries in the rear a small wheel that carries along during its revolution a similar one keyed to the axle, *a'*. This latter drives a pinion which sets in action, through the intermedium of *b'*, a rack at the lower part of the diagram table, *c'*. Consequently, this latter moves backward and forward upon its guides by a distance corresponding to the motion of the engine. At the same time, a radius-bar, *d'*, moved by the wheelcase, *j*, from which it is easily removable, traces a differential diagram. This apparatus may likewise be used as an ordinary indicator, it being only necessary to put one of the sides of the dynamometer tube momentarily in communication with the atmosphere. In order to operate this mechanism, the button, *e'*, is pressed in such a way as to compress a spring that constantly tends to destroy the contact between the two little wheels. In Fig. 2 the table is replaced by a small cylinder whose apex is likewise provided with a starting button.

The surfaces upon which the stylet rests are formed of a hard material, always ready, like a slate, to receive a diagram, which may afterward be rubbed off.

In conclusion it remains for us to give a few details in regard to these parts of the dynamometer that are actuated by the engine submitted to trial.

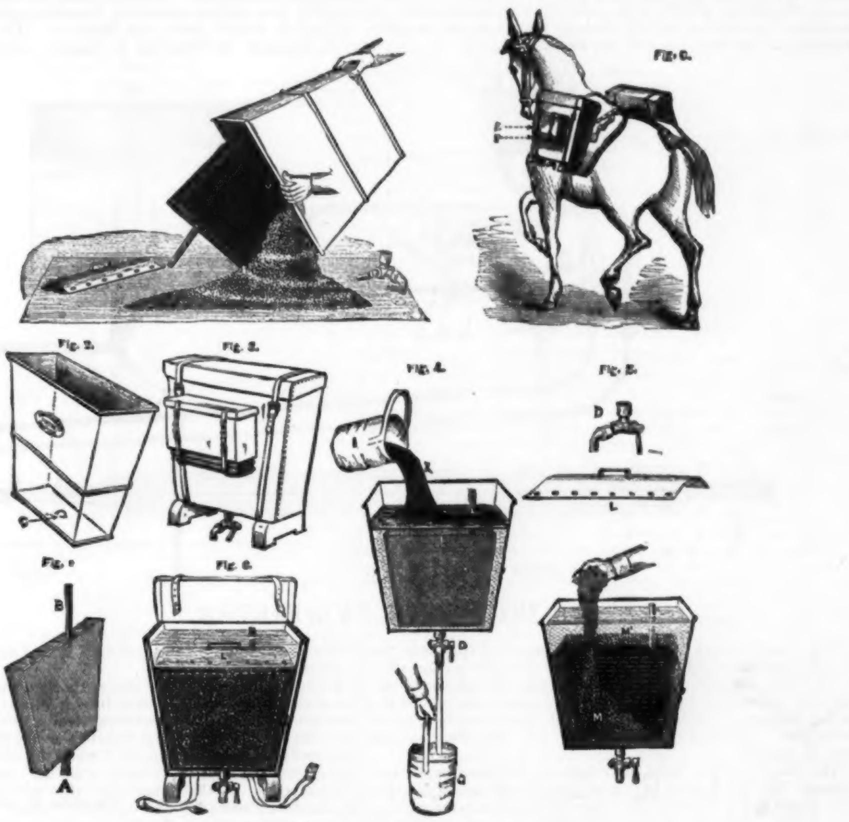
The driving pulley, C (Fig. 3), is constructed as in ordinary indicators. It carries a spring, and is fixed upon the bush of the pinion, *d*. It is driven either directly by the head of the piston (Fig. 9) or by the longitudinal shaft of an engine in which the distribution takes place through valves (Fig. 7). Mr. Puplus likewise employs for running the dynamometer a helicoidal rod designed to act as a substitute for cords, and, at the same time, to avoid spring boxes. Fig. 1 shows how this rod is mounted upon the apparatus, and Fig. 6 shows the device on a larger scale. It is easy to see that the rod, H, revolves in a support, S, at each of its extremities, and directly actuates the motive pinion. It receives its motion from a nut, T, actuated, in most cases, by the head of the piston rod (Fig. 10) or by a distributing shaft, W (Fig. 8). This nut is constructed in two pieces, which are united by small segments forming a spring, so as to assure of very slight friction. The button, *t*, revolves in its support, and actuates this nut through the intermedium of a cylindrical part, R, so that the whole forms a very simple universal joint.

This apparatus has seemed to us to merit somewhat of an extended description because of its ingenious arrangement. It may be applied not only to steam engines of all kinds, but also to pumps, fans, condensers, and other apparatus of variable pressure, without its having to be modified in any way.

In those dynamometers that are to remain fixed the counter is calculated according to the diameter of the driving cylinder, and the work is read directly; while in experimental apparatus, which are to be used upon engines of different powers, it is calculated for a cylinder one meter in diameter. The number of horses indicated upon the dial of the counter is then multiplied by the square of the diameter of the piston in meters in order to ascertain the work given by the engine.—*Revue Industrielle.*

IMPROVED ARMY FILTER.

ASSUMING for the moment that all water filtering is only mechanical—that a filter is only a fine strainer—in this case the object must be to get the greatest possible amount of surface into a given unit space, or, in other words, to get a filtering medium which shall at the same time secure perfect porosity with the smallest pores. The most obviously practicable method of doing this is to use a very finely granular material. This has been the practice in the construction of filter beds with sand, of small filters with sand and fine charcoal, and with blocks of agglomerated charcoal. This method of construction has, however, prevented the employment of powdered charcoal, inasmuch as with a mass of this material, capillarity would prevent any but exceedingly slow percolation of water if under the pressure due to a small head, while a great pressure would cause the continual removal of the powder and its mixture in a finely divided state in the filtered water. To avoid the difficulties that would thus attend the use of fine powder charcoal, Mr. Maignen uses a combination. Over a supporting structure of canvas or asbestos cloth, he causes this powder to distribute itself from the water in which it is mixed, and put into the filter for filtration. The water passes through the asbestos cloth, and leaves the powder caught in its interstices, and a further quantity deposits itself over the whole surface of the supporting material. A thin film, or one of any necessary thickness, is thus obtained of very minutely porous charcoal. This forms the central part of a filter vessel, the space around it being filled with granular charcoal. The filter thus made



IMPROVED ARMY FILTER.

up will intercept, not only the finest suspended inorganic matter, but will do the same with the small bacterium or bacillium. The filtering material thus used is not, however, simply a mechanical strainer. Carbon so finely divided has properties of a chemical or chemico-physical character, which enable it to act, as is proved by experiment upon organic and inorganic matter in solution. We have seen a solution of sulphate of iron, then a solution of acetate of lead, then of urine, passed through a filter of this kind, and exhibit afterward in the test tube no trace, or scarcely any, when treated with the proper reagents. Through a similar filter, or rather the same one recharged in a few minutes with filtering material, a bottle of claret was passed, and this came out clear white without the faintest taste of claret, but only a taste of water with a slight addition of spirit. All the color was equally taken from a solution of permanganate of potash—Condy's fluid. Whatever the cause or combination of causes, the result is as stated; and this great efficiency has caused the War Department to send out to Egypt the form of the filter we now illustrate, which is, of course, a special form made up for transport.

The filter consists of a hollow tinned iron filtering frame, Fig. 1, covered with asbestos cloth fitted with an outlet tube,

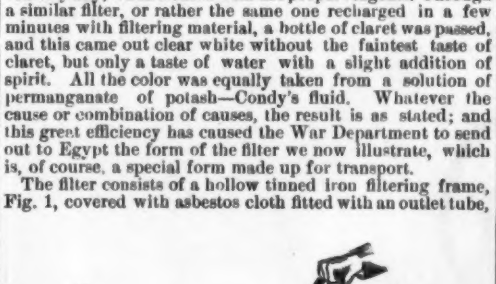


FIG. 8.

A, provided with a screw and leather washer, and at the top an air pipe, B. This frame is placed in a tinned copper case, Fig. 2, the tube, A, passing through a hole, C, in the bottom of the case. A tap, D, is provided for fitting on to the screw of the tube, A. The frame, when placed in the tinned copper case, is covered by a tinned copper perforated screen, L, through which the air pipe passes. The filter is placed in an outer leather case, Fig. 3, provided with a pocket, E, for holding twelve ½ lb. packets of finely powdered charcoal and a brush. Two folded canvas buckets, F, are strapped underneath the pocket. When in use the filter should be raised from the ground by placing it on boxes, or by attaching it to the tail board of a wagon. Water should first be poured into the filter, until it is filled nearly to the top, Fig. 4. Half of one of the packets of finely powdered charcoal is to be put into an empty bucket, G, and placed underneath the tap, D, and the other half of the packet is to be well stirred with the hand, in the other bucket, I, filled with water, and the tap, D, having been opened, poured in the filter, K. The charcoal in the bucket, G, is to be stirred up with the water coming out of the filter, and again poured into the filter, K. The water coming from the filter must be stirred in the bucket, so as to mix it with the charcoal which may have been left at the bottom, and again poured back into the filter. The object to be attained is to coat the whole of the surface of the asbestos cloth with an even layer of the finely powdered charcoal, and, to attain this object, it will be necessary to return to the filter the water that comes out until the whole of the charcoal is in the filter. The tinned copper screen, L, is now to be taken out while the filter is still full of water, and the space, M, Fig. 5, around the frame and an inch or two over M' is to be filled with granulated charcoal; about 16 lb. would be required for this purpose. The screen is then to be put in its place, and the filter is now ready for use, Fig. 6. The water that has been used in starting the filter should be thrown away. The time during which a filter thus charged will continue to be in working order will depend upon the character of the water to be filtered. The filter should be cleaned once a month, or if the water is very bad, twice a month. The following is taken from the directions for cleaning issued on cloth to the men in Egypt: Unscrew the tap and take it off; lift the filter out of its leather case. Take out the upper part of the granulated charcoal to the depth of about 2 in., and throw it away. Turn the filter over on its edge, Fig. 7, and shake the filter until the frame and charcoal fall out. This should be done on clean ground, or upon a piece of canvas, or on a board, so as to be able to recover the granulated charcoal. The granulated charcoal should be placed in the two buckets and washed with filtered water several times, the charcoal to be stirred up by the hand, and the dirty water poured off. This washed charcoal, with a little additional new charcoal, can be used over again. If the charcoal is so dirty as not to be capable of being washed clean in the manner described, it should be thrown away, and fresh granulated charcoal substituted. The filtering frame, Fig. 8, can be cleansed by dashing water, N, smartly against it.

Besides this special form, this filter is made for use by wine and spirit merchants, brewers, and, in a small form, for laboratory purposes. In breweries large sums are being saved by filtering cooler bottoms, which used to be squeegeed down into the drains, and in this way a wort of high gravity is obtained, which was previously considered worth nothing. Wort is also filtered by it before fermentation.—*The Engineer.*

BOULIER'S PYROMETER.

THE Messrs. Boulier Brothers have recently devised an apparatus which they call a "Universal Pyrometer," and which will doubtless prove of great value to scientists and manufacturers who are obliged to have recourse to the use of high temperatures.

As well known, the measurement of such temperatures is an extremely delicate, if not impossible, operation, and so much so that, in the manufacture and decoration of porcelain, no other indications are relied upon except those given by the color of the fire, which, passing successively from cherry red to white, indicates to a practiced eye the gradual rise of the temperature. But this process is not a very delicate one, for it shows only important variations, and, above cherry red, no longer gives indications that are certain, because, at this moment, the fire is too dazzling to allow its intensity to be judged of accurately.

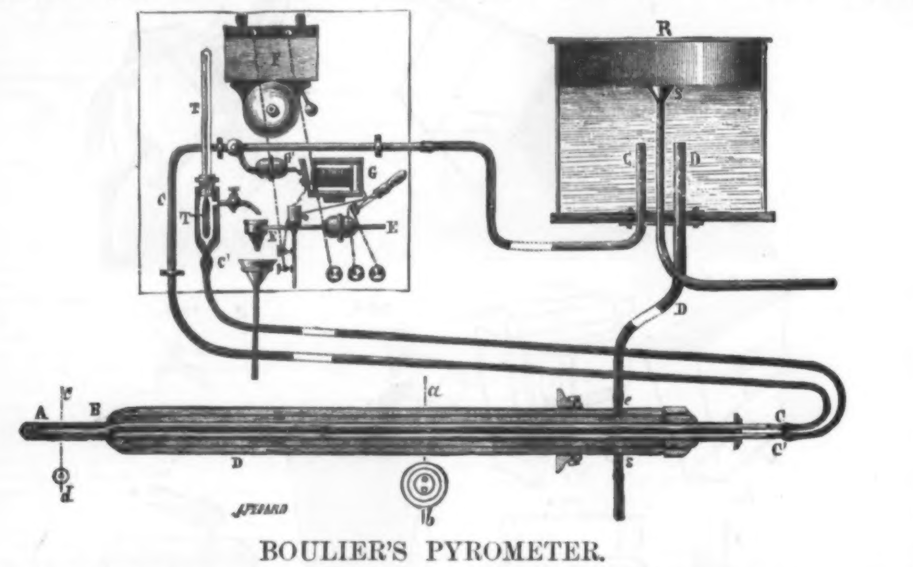
Various systems of pyrometers have hitherto been tried, but none has proved accurate enough to be employed in constant practice and with certainty; and for this reason it has been necessary to have recourse to various other artifices. But the apparatus brought out by the Messrs. Boulier has finally supplied the want that has long been felt in the industries for a measurer of heat, since it is sensitive and accurate. Its principle is exceedingly simple. It is based upon a thermometric observation of the temperature that a rapid

current of water assumes when circulating in the space to be observed. The instrument consists of three distinct parts, viz., of an explorer, a reservoir, and an interrupter.

The explorer, which is the interesting part of the apparatus, is a small cylinder, A, of very thin copper and of a few centimeters in length. One of its extremities, B, is closed, and the other terminates in two tubes, one of which, C, is in communication with a water reservoir, R, and the other, C', ends in a thermometer, T. These two tubes are inclosed in a metallic cylinder, D, that serves as a refrigerator, and that is likewise supplied by means of the tube, D', by the reservoir, R. This cylinder is 1 meter in length by 3 centimeters in diameter.

The water reservoir, R, merits no special description. It must be of constant level, and is for this reason provided with a waste pipe, S.

Finally, the interrupter consists of a small balance, E, which is so poised that the current of water shall run regularly, but which, at the least interruption therein, sets in operation an electric bell, F, and, by means of an electro-magnet, G, can even shut off the water at G.



BOULIER'S PYROMETER.

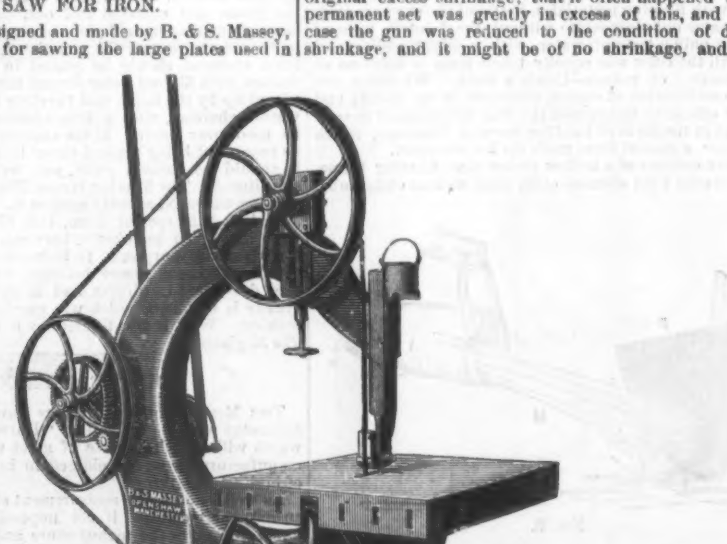
When it is desired to use the apparatus, the explorer is put in communication with the water reservoir by means of a rubber tube, and after it has been ascertained that the circulation is proceeding regularly, the explorer is introduced into the furnace or muffle and is fixed firmly into the door or outer part. In a few moments after this the observations may be begun.

The water coming from the reservoir circulates in the apparatus, becomes heated in contact with the flames or hot air, and shows by the thermometer the variations in temperature that it is undergoing. These indications are very rapid. It takes but a few seconds for the thermometer (which is very sensitive) to act. A contact of the hand with the refrigerator (the water in the reservoir being at about 15°) suffices to cause the thermometer to rise a few seconds afterward. It should be stated just here that the thermometer is graduated to twentieths of a degree.

In its present state, the apparatus indicates elevations and diminutions in the temperature very quickly and faithfully, and it may therefore be stated that it is capable of rendering genuine services in the industries. With a few improvements in its details, and with the addition of an automatic registering device, we shall have a perfect apparatus of control.—*Bull. de la Soc. d'Encouragement.*

BAND SAW FOR IRON.

THIS machine was designed and made by B. & S. Massey, Openshaw, Manchester, for sawing the large plates used in their steam hammers with wrought iron framing. To adapt it for admitting the large plates required, the usual construction with two pulleys was modified by the introduction of a third one behind the framing. This enables the framing to have a clear overhang of 60 inches, without using pulleys of inconvenient diameter, and the saws run as smoothly and easily as in the ordinary machines. Though primarily designed for Messrs. Massey & Co.'s special requirements as steam hammer makers, the machine has been adopted at a number of the Government dockyards and other large establishments. It is sometimes fitted with a self-acting table, and altogether is a tool of great utility.



BAND SAW FOR IRON.

WIRE-GUN CONSTRUCTION.

AT a recent meeting of the Institution of Civil Engineers a paper was read "On Wire-Gun Construction," by Mr. Jas. A. Longridge, C.E.

Before entering on the specific subject of the paper, the author referred to a number of documents received by the Institution from the Ordnance Department, U.S.A. These were mostly translations from the works of Virgile, Rosset, and Clavarino, and related entirely to the hoop-construction of guns. The conclusions and formulæ arrived at by these authorities completely bore out those of the author's paper of 1860, and the fundamental formulæ agreed with those derived by Lame, Hart, and Rankine. The formulæ, however, required modification in certain circumstances, when account was taken of the action of lateral forces, whether of tension or of compression.

In guns constructed on the author's principle there was no strain on the core or coil in the direction of the axis of the gun, so that only the radial compression force had to be considered; it was shown that in no case was this very important, and that its effect vanished when the modulus of elasticity of the material of the gun was the same throughout. Virgile came to the conclusion that no part of the gun should be strained beyond its elastic limits, whether in tension or compression. While agreeing with this as regarded tension, the author came to a different conclusion as regarded compression. This from his own experience might be largely exceeded without detriment, and in this he agreed with Clavarino, who expressed the opinion, fully confirmed by experiment, that a compression of three times the elastic limit was perfectly admissible. Both Virgile and Clavarino attached great importance to the proper determination of the shrinkages, in this respect agreeing with the author, who had always contended that Sir William Armstrong and the Woolwich authorities were wrong in assuming that if the actual shrinkages were in excess of those indicated by theory, the gun would shake itself right by repeated firing. This view the author contested; he pointed out that it would only be true if the excess strain caused a permanent set just equal to the original excess shrinkage; that it often happened that the permanent set was greatly in excess of this, and in such case the gun was reduced to the condition of deficient shrinkage, and it might be of no shrinkage, and would then inevitably fail. The author next referred to the failure of a 6·3 in. gun on board H.M.S. Daring on the 22d of February, 1883, resulting in the death of two men and the wounding of three others during target practice. From calculations made by him, the author concluded that the failure of this class of gun was certain, if the powder pressure was not kept down to about 10 tons per square inch, the effect of which on the efficiency of the gun need not be stated. He thought it probable that, owing to the method of construction, this gun did not actually burst, but was torn asunder by the successive permanent sets loosening the hold of the hoops upon each other between the breech and the trunnion. After referring to Rosset's experiments on "Special Elasticity," or the extension of the "Elastic Limit" by stretching, the author pointed out that inasmuch as this only took place when the stretching was the effect of mechanical force, and not when it resulted from the contraction in cooling, this property was not available in the ordinary method of gun construction, though it had some effect on the behavior of a gun under fire. After careful consideration, the author was forced to the conclusion that the construction of a perfect hooped gun was beset with enormous practical difficulties, and that the present armament of the country was unreliable.

Turning to wire guns, the author remarked that there was a good deal of misconception on the subject. It was not that a material in the form of wire was much stronger than the same material in mass, and that the method of coiling it on was expeditious and convenient. This was true; but the essential feature of wire-gun construction consisted in the facility it afforded of bringing the body of the gun into the proper state of varied initial tension, in order that when the powder-pressure acted every portion of the coil might be equally strained to a predetermined tension. Thus the important question was to determine the proper tension with which to lay on the wire. It was maintained by some that the tension should be uniform, and by others that it was sufficient to lay the wire on with just enough strain to insure close contact. The latter plan had been adopted by Dr. Woodbridge in the 10 in. gun constructed at Frankford Arsenal, in 1873, for the United States Government. After briefly describing that gun and its mode of construction the author pointed out the impossibility of its proving a success, being wrong both in principle and in practice.

The author then proceeded to enunciate the problem, and to enumerate the variables on which it depended. By a series of diagrams he showed that by a proper formula it was possible to determine the exact laying-on tension of each coil of wire, so that when the powder-pressure acted every wire should be uniformly strained to the allowed limit, which should always be kept well within the elastic limit of the wire. The diagrams also demonstrated the strains both of the coil and of the core, when under fire and when at rest. There were three sets of these diagrams, in the respective cases where the modulus of elasticity of the core was 4,500 tons, 9,000 tons, and 22,000 tons, that of the wire being 22,000 tons throughout; and they showed clearly the great advantage of a core of low modulus. In the next section the author dealt with the case of laying on the wire with uniform instead of varying tension, and by a series of diagrams he showed how very important it was to determine the proper amount of this tension if uniform. He also showed that for each individual gun there was one "particular" tension of laying on which gave the best result, and that this particular tension might be found by the formulæ. The formulæ and diagrams also demonstrated the condition of the respective guns when under fire and when at rest. A further set of diagrams showed the serious error that had been made in Captain Schultz's 34 centimeter gun, if the account of its construction in the United States Ordnance report was correct. Clavarino's hypothesis, that the strength of a gun was measured by the "extension" and not by the "tension" of the material was shown to be ill grounded. Proceeding to the objections which had been made to wire guns, namely, want of longitudinal strength, derangement of tensions by heating, and crushing the core by the compressive action of the coil, the author pointed out that such objections had no validity, provided the gun was constructed properly.

The next section of the paper was devoted to a brief examination of the practice of "chambering." This was maintained to be only a device for reducing the initial pressure of the powder gases to such an extent that it would not overcome the inherent weakness of the guns of the present day. A comparison was made of two 12 in. guns, one with a large chamber, the other unchambered, and it was shown that while the two guns were equally strained by the explosion, the chamber gun, with 500 lb. of powder, imparted about 19,000 foot-tons of energy to the projectile; the unchambered gun, with 413 lb., gave nearly 30,000 foot-tons. Some remarks were then made upon slow burning powder, and it was maintained that it was a retrograde step as regarded ballistic effect, and was only called for by the weakness of the gun.

The principal inferences drawn from the investigations on which the paper had been founded were three:

First, the paramount importance of a proper formula for the laying-on tension of the wire. Second, the advantage of a core of material of a low modulus of elasticity, such as cast iron. Third, the advantage of a thin core. In an appendix were given the principal formulæ for the construction and the calculation of the strength of these guns, and a few examples of their application.

SUBMARINE EXPLORATIONS.*

THE fishing apparatus used on board the Talisman consisted of dredges and drag-nets, but recourse was only had to the former of these when an exploration was to be made of rocky bottoms that would have torn the nets.

The drag-nets that were almost constantly used were two or three meters in diameter at the mouth, like those used on the American steamer Blake during Agassiz's cruise in the Gulf of Mexico. The results obtained with these apparatus were so wonderful that Mr. Milne Edwards had to remark in his lecture before the Geographical Society upon the dredging expedition of 1883, that it is to drag-nets "that we owe the admirable collections that have been made. They never failed us, and to a depth of 5,000 meters gave just as good results as those that our fishermen obtain on trailing their nets at a depth of a few fathoms." We represent in Fig. 1 one of the drag-nets employed on board the Talisman.

Upon examining the engraving it will be seen that the arrangement of the net's mounting was such that, on whatever side the apparatus reached bottom, it was always sure to drag effectively. The net fixed to the iron frame was made of very strong hempen cord. It consisted of two parts, one set within the other. At the extremity of the external bag there was fastened a large cast iron ball in order to keep the net extended out upon the bottom. The internal bag, which was open beneath, was designed to prevent objects that had entered the net from getting out again.

During the course of the cruise, Commandant Paris conceived the idea of placing one of those mops that are used for washing decks in the bottom of the net. The results

* Continued from page 6922.

that crowned the experiment were so remarkable that thereafter recourse was continually had to the innovation. The success was due to the fact that a host of small animals, such as crustaceans, mollusks, ophiurians, etc., which had been carried in by the renewal of the water in the net, and would have passed through the meshes of the latter, were caught in the midst of the long fibrous material composing the mop. A large number of small and delicate specimens, which had up till then escaped us, were from that moment always brought on board.

The hempen nets were extremely strong, as will be seen from the following example: On the 29th of June the net was lowered to a bottom situated at a depth of 905 meters. When it was drawn up on board there were found within it 250 kilogrammes of rocks, and yet none of its meshes had given away under the enormous traction developed by such a weight.

When dredging was to be done, the apparatus that we have just described was used as follows: In the first place, the cable was unwound from its bobbin and passed over guide pulleys placed flat upon the deck behind the laboratory. This arrangement is represented in a previous figure giving a plan of the vessel. Then the cable was carried forward and given a few turns around the large drum of the lifting windlass (Fig. 2). Afterward it was carried over two forward guide pulleys that permitted it to run up a spar. The two forward guide pulleys are seen in Fig. 3. After reaching the outer end of this spar it passed into a pulley whose mode of suspension will be described further along, and was firmly attached to the drag-net by a shackle and bolt.

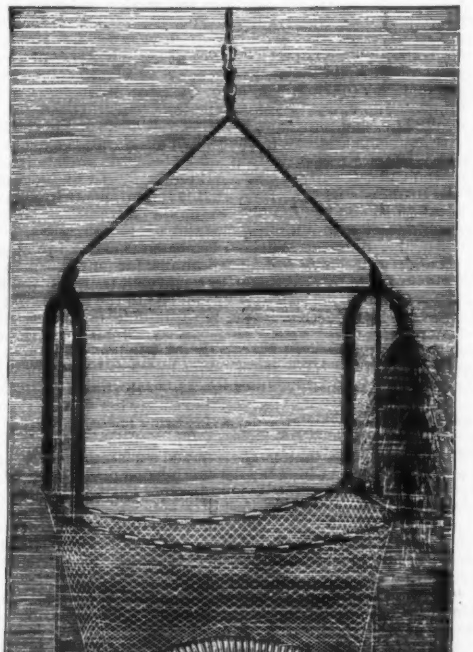


FIG. 1.—DRAG NET EMPLOYED ON THE TALISMAN.

During the operation of dredging it is of the highest importance to know what traction the cable is supporting. In order to get at this, an accumulator was arranged on the mizzenmast. This apparatus is shown in diagram in Fig. 3. It consisted of vulcanized rubber disks separated from one another by iron washers. Both the disks and washers were perforated in the center in order to give passage to a very strong metallic rod that terminated below in a disk. Four metallic rods, not so strong as the other, were inserted into the upper washer and terminated in a second disk that was placed above that of the principal rod, and that carried a ring. To the upper extremity of the principal rod there was firmly fastened a metallic cable which ran up along the mizzenmast, passed through a pulley fastened beneath the mizzenyard, and ran to the end of the spar. The cable at this level was fixed very firmly to the pulley over which passed the steel cable connected with the net. Consequently the last pulley over which the cable ran before descending to the sea was not fixed to the end of the spar, but was attached to the cable of the accumulator. In this way the latter received the impression of the weight of the drag-net, of the weight of the cable unwound, of the pressure to which these objects were submitted, and, finally, if the traction exerted by the drag-net while moving over the bottom.

According to the depth to be explored, and also according to the weather, a drag-net of two or even of three meters was employed. In a general way, it may be said that, in fine weather, a three-meter net was used for exploring depths of 3,600 meters. Beyond such a depth a net of only two meters was employed.

When all was ready for casting the net, the machines were ungeared and the apparatus was in the first place allowed to descend under the sole influence of its own weight and that of the cable to which it was attached. But, after a while, the descending velocity increasing too greatly, was moderated by causing the windlass brakes to act.

During the descent of the drag-net the vessel was sailed before the wind by means of her flying jibs and mizzen spanker. It was necessary that she should sail at the rate of two knots, but if the wind was not strong enough to permit her to do this, her speed was accelerated by means of the engine. It had been ascertained that a speed of 2 or 3 knots was absolutely necessary in order to keep the cable constantly taut. If the tension was not kept up, the cable descended with more velocity than the net, and accumulated upon the bottom, and the net finally fell upon the pile thus formed. In such a case the cable formed coils over a large extent of its length (sometimes over 200 meters), and it became difficult to straighten it out again.

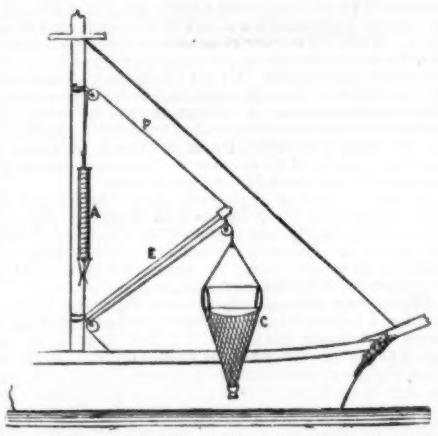


FIG. 3.—THE ACCUMULATOR AND THE MODE OF SUSPENDING THE NET.

A. Accumulator. B. Spar. C. Drag-net. P. Stretcher.

A counter annexed to the windlass, over the drum of which passed the steel cable before descending to the water, allowed the moment to be known at which the net reached bottom.

In order to assure of the net being drawn along the bottom, it was necessary to unwind a length of cable greater than the depth of the sea at the level of the point where the vessel was lying. Up to 600 meters, the length of cable paid out was double the depth, and beyond this, six or eight hundred meters more than the depth were unwound.

The time during which the net was left upon the bottom varied greatly with the depth. In deep dredgings it was dragged for three quarters of an hour, and sometimes even for several hours. When it was supposed that the submarine exploration had gone far enough, the brakes were unlocked and the windlasses were set in motion. The first of these latter draw up the net and the second served for winding the cable upon the bobbin in measure as it came up on deck. The unwinding of the cable was effected at the rate of 100 meters per minute, and the winding at the rate of 40. When the net came out of the water, it was swung over the deck in the position shown in Fig. 2.

In order to obtain the animals inclosed in the thick and glutinous slime that was often brought up by the net, it was necessary to manipulate the latter with great care. For this operation there was used a superposed series of large metallic boxes mounted upon rollers, which were moved backward and forward while the slime was being diluted with a gentle stream of water in order to disengage the smallest animals without breaking them. This operation is shown in Fig. 2, which was engraved from a photograph taken by Mr. Vaillant.—*H. Filhol in La Nature.*

ELECTRO-PLATING WITH NICKEL.*

By WILLIAM H. WAHL.

NICKEL plating is an American industry, in the sense that it was first successfully practiced on the commercial scale in the United States, and here received that practical demonstration of its usefulness that has since made it the most successful and most widely practiced branch of the art of electro-plating. Coming first into prominence and popularity about ten years ago, it has since that time rapidly grown, until to-day it has developed into an industry of great magnitude. The almost silvery whiteness and admirable brilliancy of electro-deposited nickel, its cheapness as compared with silver, the hardness of the electro-deposited metal, which gives the coating great power to resist wear and abrasion; the fact that it is not blackened by the action of sulphurous vapors which rapidly tarnish silver, and the circumstance that it exhibits but little tendency to oxidize even in the presence of moisture, are sufficient to explain the great popularity which nickel plating enjoys.

The industrial development of the art, however, which has been surprising both in respect to its rapidity and extent, may be attributed, in a large measure, to certain favoring circumstances, quite independent of the excellent adaptability of the metal for electro-plating purposes. These circumstances are: first, the great advances that have been made, within the period above named, in the production of nickel on the commercial scale, by which the cost of the metal has been greatly reduced, and its purity greatly increased, for which we are indebted largely to the American Nickel Works of Camden, N. J., under the scientific man-

* A paper read before the Chemical Section of the Franklin Institute, November 6, 1883.

FIG. 2.—EMPTYING THE NET.

agement of Mr. Joseph Wharton;* and second, the introduction and great improvement within this period of the dynamo-electric machine, which placed at the disposal of electro-platers a constant, powerful, and cheap source of electricity in the place of the uncertain, troublesome, and comparatively expensive voltaic battery, to the use of which they had of necessity been hitherto confined. Alex. Watt† was among the first, I believe, to call attention to these facts. He states, for example, that "the difficulty in obtaining pure nickel anodes of large surface for many years checked the progress of this useful art, while the slow and uncertain action of the ordinary battery rendered it ill suited to the deposition of this peculiar metal on the large scale;" again, "it is doubtful whether nickel plating would ever have held a really high position in the arts, if the dynamo-electric machine had not been introduced;" and in another place: "Indeed, as we have said, it is doubtful if this branch of the art (*i. e.*, nickel plating) could even have been extensively pursued with advantage on a large scale, if battery power alone were available." In considering the subject of the present very extensive application of nickel plating, therefore, the above facts and explanations should not be lost sight of. So general has the demand for nickel plating grown to be, and so universally is it employed, that, for the sake of economy, hundreds of establishments throughout the United States engaged in the manufacture of the most miscellaneous articles of brass, copper, iron, and steel have introduced the nickel-plating plant, and do their own plating. Furthermore, innumerable small articles of metal of trifling value are nickel plated after a fashion, by the manufacturers, not to protect them from the action of corrosive agents, but simply to catch the eye of the purchaser and to make them sell. As may readily be imagined, this state of things has produced a severe competition among those engaged in the business of nickel plating, which, while it has had the effect of bringing down prices to extremely low figures, has incidentally also had the effect of causing a very general deterioration of its quality.

An enumeration of the great variety of products that are nickel plated would be impossible; among them may be named dental and surgical instruments of every description, harness and saddlery trimmings, carriage fittings, spoons and forks, locksmith's work, brass cocks and faucets, and the decorative metal work of plumbing and sanitary wares, scale and balance beams and weights, mountings of guns and pistols, the metal parts of lamps and lanterns, fire grates and fixtures, stove decorations, door plates, cuspadores, watch and clock cases, handrails of railway cars and car seats, etc., stair rods, points of lightning rods, show cases, the external parts of sewing machines, steam and water valves, gauges, and miscellaneous machinery accessories without number.

From the very brief account that M. Roseleur gives of this subject, it would appear that the art of nickel plating had received little or no attention in France up to the year 1880;‡ furthermore, from the somewhat contemptuous reference with which he dismisses it, it is apparent that at that time he had no knowledge of the remarkable progress and development of the art in this country, and no conception either of the perfection to which the processes had been brought or the beauty and utility of the results obtained.

Although, however, it would appear from the remarks of the author just referred to that nickel plating had received but little attention in France up to the year 1880, the art appears to have been transplanted to England with much success, as the following reference to the subject by Watt§ will testify:

"The time has now arrived, however, when it may be fairly stated that the art of nickel plating has become, in proper hands, one of the most successful, and at the same time one of the most extensive, branches of electro-deposition. For several years nickel plating in this country (*i. e.*, England) had been principally confined to some three or four houses. Now, however (1880), the process has been most extensively adopted in London and throughout the kingdom, as also in many foreign countries. There is no doubt that its extensive application in the United States acted as a stimulus to our own manufacturers, who have steadily, though tardily, recognized in nickel a most useful coating for certain kinds of metal work."

NICKEL SOLUTIONS.

One of the earliest allusions to the electro-deposition of nickel is that of M. Ruoltz*, in the year 1841. The reference is as follows:

"The same method, that is, the use of a solution of the double cyanide in water (prepared by dissolving the metallic oxides in cyanide of potassium), may be employed for coating other metals with copper, tin, cobalt, *nickel*, and zinc."

In 1843 Smee† states that "metals may be covered with nickel by proceeding as in former cases. The solution to be used is the chloride of nickel with a nickel positive pole. The single battery process is to be preferred, but pure nickel, though *very brilliant*, is apt to be rather brittle. . . . It is best reduced by the compound battery process, with a platinum positive pole, though a nickel positive pole may be employed. When we employ either the nitrate or sulphate of nickel for electro-metallurgy, it is preferable to use the solution as strong as possible. Of the compounds of these salts with the alkalies, those with ammonia deserve the preference, and the ammonio-nitrate and the ammonio-sulphate may be used for the reduction of this rather troublesome metal."

In the same year (1843), Dr. R. Boettger‡ published an interesting account of his experiments in plating with nickel, from which I take the following quotations:

"No salt of nickel or of platinum has yet been found well adapted to plating baser metals with nickel or platinum. Experience has taught that a compound of cyanide of nickel with cyanide of potassium, according to the statement of Ruoltz, by no means attains the object, nor is the platinum salt recommended by him any better.

"From a long series of experiments expressly made on this point, I believe I have discovered, and can give the assurance, that among all the salts of nickel none is so well adapted to plating, especially on copper or brass, as the ammonio-sulphate of nickel; at least, the cyanide of nickel and potassium recommended by Ruoltz is far inferior to it, even in a very long-continued, constant current. Sheet copper comes out of the solution of ammonio-sulphate of nickel almost *silver white* and *brilliant*. I have obtained in this manner, after the action of a moderately strong galvanic current for half an hour, a considerable deposit of nickel on copper, quite sufficient to deflect violently from the magnetic meridian a magnetic needle suspended by a fiber of silk. A drop of common nitric acid on the nickel coating exhibited in a given time no sensible action on the subjacent metal, while sheet copper which had been allowed to remain in a gliding bath under the influence of the current for the same length of time was almost instantly attacked by nitric acid. From this it may be inferred that the galvanically deposited nickel coats the copper more rapidly, adherently and uniformly than gold similarly deposited.

"To prepare the salt of nickel here referred to, the impure nickel of commerce suffices completely. To this end, it is dissolved in nitric acid, a stream of sulphureted hydrogen is passed through the solution for some time in order to precipitate all copper and arsenic, and the filtered solution is then precipitated by carbonate of soda. The well washed carbonate of nickel is dissolved in dilute sulphuric acid, and the solution is placed beneath a bell-glass over concentrated sulphuric acid, in order to obtain it crystallized. These crystals are pulverized, transferred to a suitable flask, and ammonia gradually poured over them, until sufficient has been added to dissolve them. The resulting fine, dark-blue solution may be directly used for the purposes above named."

It may be proper to add, in this connection, that one of the uses suggested by Boettger for his solution is for the preparation of pure sheet nickel.

In the fourth edition of his work Roseleur§ affirms that as early as the year 1849 he had succeeded in the establishment of M. Kraintz, at Grenelle, in obtaining on table ware an excellent deposit of nickel of considerable thickness, with the use of the double sulphite of nickel and ammonium as the depositing solution.

The next important contribution to the art of depositing nickel by galvanic means is made by Mr. George Gore, who, in 1855, employed the double salts of nickel and ammonium, *i. e.*, the double chloride. In the edition of his work on *Electro-Metallurgy*, published in 1860 (Griffin & Co., London, 1860), he describes a method for the electro-deposition of nickel by means of a solution of the double chloride of nickel and ammonium.

In 1862, MM. Becquerel, *pere et fils*, read before the French Academy a paper on the "Electro-Chemical Reduction of Nickel, etc.,"‖ from which I quote as follows: "Nickel, we operate with a solution of sulphate of nickel to which has been added caustic potassa, soda, or ammonia, preferably the latter alkali, to saturate the excess of acid. Sulphuric acid becoming free is saturated by oxide of nickel placed on the bottom of the vessel, or by adding alkali to the solution, ammonia by preference. At the end of a certain time we obtain a brilliant white deposit with a slightly yellow tint. According to the moulds employed, it may be obtained in cylinders, bars, or medals. They possess, like cobalt, magnetic polarity when taken out of the solution. The ammoniacal solution of the double sulphate of nickel and ammonium, and even that which is not ammoniacal, likewise furnish metallic nickel."

In 1869, Isaac Adams,¶ Jr., of Boston, obtained a patent in the United States for an "Improvement in the Electro-Deposition of Nickel," in which he describes a method of preparing the double salts of nickel—the double sulphate of nickel and ammonium, and the double chloride of nickel and ammonium—by which the same are obtained free from certain impurities, to the presence of which, he claimed, the difficulties in the way of obtaining a satisfactory deposit of this metal by galvanic means were ascribable. He describes in his patent specification a method of preparing these two compounds in such a manner as to be free from the presence of potash, soda, lime, alumina, and nitric acid, and directs that the electro-deposition of nickel by means of either of these double salts must be done from a solution that is free from acid or alkaline reaction. He likewise claims as his invention a method of preparing the nickel plates to be used as anodes in the depositing cells, which consists in melting the nickel and combining it with iron, for the purpose of avoiding the bad effects produced by copper and arsenic when these are present as impurities in commercial nickel. The effect of the addition of iron to the nickel (the amount being the chemical equivalent of the copper and arsenic present), Mr. Adams affirms, is to prevent the deposition of the above named impurities with the nickel. Quoting from the specification, "the iron itself is almost wholly precipitated as a peroxide, and is not deposited with the nickel to a sufficient extent to injure the character of the deposit. Neither does it injuriously affect the solution. The effect of the iron upon the copper is either to prevent it from being dissolved, or, if dissolved, to immediately reduce it upon the anode, where it forms a coating which may be reduced from time to time by scraping. The arsenic forms an insoluble precipitate with the persalt of iron."

Mr. Adams continues:

"Having prepared the solutions and anodes, as herein described, nickel may be readily deposited; but, in order to carry on the deposition continuously, it is necessary to observe certain precautions: First, the use of a battery of too high an intensity must be avoided. An intensity of two Smee cells is sufficient. A high intensity decomposes the solution and liberates free ammonia, thus rendering the solution alkaline, and impairing its value. Whenever the smell of free ammonia arises from the decomposing cell, the operator may be certain that the solution is being injured. It is important that the depositing shall not be forced by the use of too strong a current. Second, it is important that great precaution should be used to prevent the introduction into the solution of even minute quantities of potash, soda, or nitric acid. When an article to be coated is cleaned in acid or alkaline water, or is introduced into it for any purpose, the greatest care must be taken to remove all traces of these substances before the article is introduced to the nickel solution, as the introduction of the most minute quantities of acids or alkalies will surely be injurious. It is important that the solution be kept free from all foreign substances, but its purity from those above named is especially important. Third, the anode of the depositing cell should present a surface to the action of the solution somewhat larger than the surface upon which the deposit is being made, particularly in the double sulphate solution. The reason is that nickel dissolves so slowly, that if the exposed surface is not larger than the surface on which the deposit is being made, the solution will not keep saturated. On the other hand, if the anode is very much larger than the positive pole, it tends to give a deposit of black powder. Fourth, if zinc is to be coated, it should first be coated with copper, as it is difficult to make nickel adhere to zinc, and there is danger that the zinc may be acted on and injure the solution.

"With solutions and anodes thus prepared and used, the deposition of nickel can be carried on continuously and almost as surely and certainly as the deposition of copper from the common sulphate solution, though the limits of the battery-power which may be used are narrower. The metal deposited is compact, cohesive, and tenacious. It may be deposited of nearly uniform thickness over any surface, however large. The deposited metal is capable of being annealed by a heat below a low-red heat. It then becomes flexible, malleable, and ductile. The deposit may be made of any required thickness, either to furnish effectual protection to the metal on which it is deposited, or to be removed and used separately from the surface on which it may be deposited."

In the same year, but a few months earlier than the date of the patent above referred to, a patent had been granted to the same inventor for the use of a solution of the sulphite of nickel in a solution of sulphite or bisulphite of ammonium.* This solution is identical, apparently, with that which M. Roseleur claims† to have used as early as 1849, with excellent results, in the establishment of M. Kraintz at Grenelle, but which, as I glean from a *Notice supplementaire sur le Nickelage*, which he has lately issued, he has discarded in favor of the double sulphate.

The Adams patents were the first on the subject of nickel plating in the United States, and the rapid development of of the art to the proportions of an important industry, which took place within a few years thereafter, gives color to the claim that Mr. Adams is entitled to the credit of being the originator of the art of nickel plating. I have elsewhere pointed out that the true explanation of the remarkable growth of this art is to be found in the substantial improvements in the metallurgical treatment of nickel, by which anodes of any desired size, and of great purity, were placed at the service of the nickel-plater; and more especially in the invention and improvement of the dynamo-electric machine, which has made the nickel-plater independent of the uncertain and troublesome voltaic battery. Had it not been for the want of these two important elements of success in this branch of the galvanoplastic art, plating with nickel would unquestionably have been extensively practiced years before it actually assumed a position as a successful and popular industry.

It cannot be denied, however, that Mr. Adams, by directing the attention of technologists to the excellent qualities of the double salts of nickel and ammonium at a time when everything was ripe for the new industry, materially assisted in calling it into existence, and in assuring its commercial success.

The years immediately succeeding 1869 were very prolific of inventions relating to the art of nickel plating, many of which, however, were comparatively valueless. I select for notice a few that appear to have meritorious features.

In 1877, John Unwin‡ of Sheffield (England) devised an ingenious process of preparing the double salts of nickel and ammonium. This consists in preparing a strong solution of sulphate of ammonium, by dissolving the salt in hot water in the proportion of about 4 pounds of the salt to each gallon of water, then filtering if necessary, and allowing the liquid to become cool. The double sulphate of nickel and ammonium is obtained by adding this solution to one of the sulphate of nickel. The novelty of Mr. Unwin's process, however, resides in the fact that he does not stop the addition of the sulphate of ammonium when sufficient has been added to combine with all the sulphate of nickel present, but continues to add it in large excess. "I do this," says Mr. Unwin, "because I have discovered that the double sul-

* Mr. Wharton has produced at his works in Camden, N. J., since the year 1876, to the close of the year 1882, 1,466,765 pounds of metallic nickel. He began experimenting very early to determine whether nickel could not be produced in a pure and malleable condition, susceptible of being worked in nearly the same manner as iron, and of being applied in the manufacture of various objects demanding a strong, non-oxidizable metal. He succeeded so well that he was enabled to display at the International Exhibition in Vienna, in 1873, a sample of nickel in the form of axles and axle bearings; and at the Philadelphia Exhibition, three years later, he exhibited a remarkable series of objects made of *wrought nickel*, such as bars, rods, etc. These objects, from their unpretentious character, did not attract the attention they deserved. As a matter of justice to this indefatigable and intelligent worker, the fact should be placed on permanent record that he had succeeded as early as the year 1873, and with the lean and sulphureted ores of Lancaster Gap, Pennsylvania, which yield only from 1½ to 2 per cent. of nickel, in producing the metal in malleable condition.

The recent discovery of pure carbonated and oxidized ores of nickel in the French colony of New Caledonia, has greatly stimulated the production of this metal and lessened its price; and the highly ingenious refining process recently discovered by Dr. Fleitmann, which is now altogether used in the production of the pure metal, has tended in the same direction.

The subject is of such interest that I quote the following brief account of Fleitmann's process from a paper read before the American Institute of Mining Engineers, at their meeting in Boston, in 1882, by Prof. W. P. Blake, of New Haven, viz.:

"Dr. Fleitmann, of Iserlohn, Westphalia, Prussia, has improved and cheapened the operation of refining nickel and toughening it, and has reduced the liability to the presence of blow holes in castings by adding to the molten charge, in the pot, when ready to pour, a very small quantity of magnesium. This is immediately decomposed, magnesia is formed, and graphite is separated. It would seem that the magnesium decomposes the occluded carbonic oxide, or reduces it to a minimum. The magnesium must be added with great care, and in small portions, as it unites explosively with the charge. It is stirred in. About one ounce of magnesium is sufficient for 60 pounds of nickel. From three-quarters of an ounce to 54 pounds of metal have been used with success by Mr. Wharton. The nickel from the ore at Lancaster Gap seems not to require as much as the foreign metal. It is to be noted that complete malleability of nickel was obtained at Wharton's works in Camden before Fleitmann's invention or process, but this last is more rapid and better than the old method. The metal so treated becomes remarkably tough and malleable, and may be rolled into sheets and drawn into wire. Cast plates can be successfully rolled. The cast plates, such as are made for anodes, after reheating, are rolled down to the desired thickness. It is found that it is a great improvement to the nickel anode plates to roll them down. They dissolve with greater uniformity in the bath. Nickel so treated with magnesium has been rolled into sheets as thin as paper. Expensive works for rolling the metal have been erected by Mr. Wharton at Camden. There is already a train of 40-inch rolls, 18 inches in diameter, with annealing ovens and gas furnaces and their adjuncts, and a 90 horse-power engine. The largest sheet yet rolled at Camden is 72 inches long and 24 inches wide, of pure nickel.

"Dr. Fleitmann has also succeeded in welding sheet-nickel upon iron and steel plates, so as to coat them equally on each face with a layer of nickel. The quantity preferred by weight is $\frac{9}{10}$ iron and $\frac{2}{10}$ nickel, one-tenth of nickel being placed on each surface. To secure union, the iron or steel must be perfectly flat and clean. A pile is made with outer facings of sheet-iron, to protect the nickel from scaling. When the whole is heated to the proper degree, it is passed through the rolls. The two metals become so firmly united that they may afterward be rolled down two or three together, or separately, to the thinness desired."

Consult also, *Jour. Franklin Institute*, cxvi., 60, *et seq.*, Art. Notes on the Metallurgy of Nickel in the United States. By Wm. P. Blake, F.G.S.

Also *Galvanoplastic Manipulations*. By William H. Wahl, Ph.D. Philadelphia: H. C. Baird & Co., 1883.

† "*Electro-Metallurgy*, Practically Treated." By Alexander Watt, F.R.S.S.A. 7th Ed., 1880, p. 86, *et seq.*

‡ *Manipulations Hydroplastiques*, etc.; *par* Alfred Roseleur. 4e. Ed. Paris, 1880, p. 300.

§ *Electro-Metallurgy*, p. 37, *et seq.*

* Ruoltz, *L'Institut*, Nr. 414, p. 410; also Berzelius *Jahresber.* xxii., p. 98.

† Smee, *Elements of Electro-Metallurgy*, 2d (Lond.) Ed., 1843, pp. 154, 219.

‡ *Jour. f. prakt. Chem.*, xxx., p. 267, *et seq.*

§ *Manipulations Hydroplastiques*, etc.; *par* Alfred Roseleur. Paris, 1880, p. 301.

‖ *Reduction electrochimique du cobalt, du nickel, de l'or, de l'argent et du platine*; par MM. Becquerel et Ed. Becquerel. *Comptes Rendus*, lv., p. 19, *et seq.*

¶ Consult U. S. Pat., No. 93,157, August 3, 1869; or British Pat., No. 31,261, October 26, 1869.

* Consult U. S. Pat., No. 90,332, May 25, 1869.

† See *ante*.

‡ Consult British Pat., No. 1,548, April 30, 1877.

phate of nickel and ammonia is far less soluble in the solution of sulphate of ammonia than in pure water, so that it is precipitated from its solution in water on adding sulphate of ammonia. I therefore continue adding the solution of sulphate of ammonia, continuously stirring, until the liquid loses nearly all its color, by which time the double sulphate of nickel and ammonia will have been precipitated as a light-blue crystalline powder, which readily settles to the bottom of the vessel. I then pour off the liquid from the crystalline precipitate of double sulphate of nickel and ammonia, and wash the latter quickly with a strong, cold solution of sulphate of ammonia as often as I consider necessary for its sufficient purification." By this procedure, it will be perceived, the double salt of nickel and ammonium is thrown down in a pulverulent, granular condition, readily soluble in water, and therefore ready for use in the depositing fat, without waiting for the tedious process of crystallization.

In 1878, Edward Weston,* of Newark, N. J., noticing its favorable influence upon the electro-deposition of nickel, secured a patent for "the electro-deposition of nickel by means of a solution of the salts of nickel, containing boric acid, either in its free or combined state. The nickel salts may be either single or double." Mr. Weston affirms that the presence of boric acid prevents the deposit of sub-salts upon the articles in the bath, which is apt to occur if the bath is not in proper working condition; he claims, furthermore, that its addition in either the free or combined state to a solution of nickel salts diminishes the liability to the evolution of hydrogen when the solution is used for the electro-deposition of nickel, and increases the rapidity of deposition, by permitting the use of a more intense current, and improves the character of the deposit by rendering it less brittle and increasing its adhesion.

The results of extended practical trials of Mr. Weston's formula, made by the writer, have convinced him of the substantial correctness of the claims of this inventor. Where the double sulphate of nickel and ammonium is used, the addition of boric acid in the proportion of from 1 to 3 ounces to the gallon of solution gives a bath less difficult to maintain in good working order, and affords a strongly adhesive deposit of nickel. The deposited metal is dense and white, approaching in brilliancy that obtained from the solution of the double cyanide.

In 1880, J. Powell,† of Cincinnati, patented an electro-depositing solution "composed of the pyrophosphate of soda, phosphate of nickel, the bisulphite of soda, and citrate of nickel and ammonia."

In the same year C. G. Pendelton,‡ of New York, patented the use of an acid solution of the acetate of nickel. The inventor emphasizes the caution that this solution must always be kept acid. The metallic strength of this solution is fully maintained by the solution of the anodes, and the bath consequently requires no additions of fresh salt.

A interesting suggestion is that patented in 1880 by Mr. Powell,§ and which covers the use of benzoic acid in nickel-plating solutions.

In describing his improvement Mr. Powell calls attention to the fact (?) that simple salts of nickel cannot be used on account of their failure to yield a regular deposit. He claims to have discovered that the addition of benzoic acid to any of the nickel salts arrests in a marked degree the tendency to an imperfect deposit, and prevents the decomposition of the solution and consequently the formation of sub-salts. The amount of benzoic acid necessary to be added to the bath for this purpose is said to be ¼ ounce to the gallon of solution. He, therefore, claims "an electro-depositing solution consisting of a soluble salt of nickel, its solvent, and benzoic acid." This bath is reported to give very satisfactory results.

In the same year, Mr. J. H. Potts,‖ of Philadelphia, was granted a patent for an improved solution for the electro-deposition of nickel "consisting of the acetate of nickel and the acetate of lime with the addition of sufficient free acetic acid to render the solution distinctly acid." Mr. Potts prepares his bath as follows: He precipitates the carbonate of nickel from a boiling aqueous solution of the sulphate by the addition of bicarbonate of sodium, filters, and dissolves the well-washed precipitate in acetic acid, with the aid of heat.

The acetate of calcium he prepares by treating caustic lime or the carbonate (marble-dust) with sufficient acetic acid to dissolve it with the aid of heat. The solution of these salts is acidified, slightly but distinctly, with acetic acid.

This solution, which I have worked with under a variety of circumstances, is in many respects an excellent one. It gives satisfactory results, without that care and nicety in respect to the condition of the solution and the regulation of the current which are necessary with the double sulphate solution. The metallic strength of the solution is fully maintained, without requiring the addition of fresh salt, the only point to be observed being the necessity of adding, from time to time (say once a week), a sufficient quantity of acetic acid to maintain a distinctly acid reaction. It is rather more sensitive to the presence of a large quantity of free acid than to the opposite condition; as in the former condition it is apt to produce a black deposit, while it may be run down nearly to neutrality without notably affecting the character of the work. The deposited metal is characteristically bright on bright surfaces, and requiring but little buffing to finish. It does not appear, however, to be as well adapted for obtaining deposits of extra thickness as the commonly used double sulphate of nickel and ammonium. On the other hand, its stability in use, the variety of conditions under which it will work satisfactorily, and the trifling care and attention it calls for, make it a useful solution for nickeling.

FORMULÆ FOR NICKEL-PLATING SOLUTIONS.

No. 1.

Double sulphate of nickel and ammonium	5 to 8 parts.
Water	100 "

Dissolve the nickel double salt in above quantity of water with the aid of heat. Cautiously add ammonia, or the sulphate of ammonium, until the solution is neutral to test-paper. This solution should be maintained as nearly neutral as possible in use. This is commonly known in the United States as the Adams solution. It is in very general use by nickel-platers throughout the United States, and yields, where properly managed, excellent results.

* Consult U. S. Patent, N. 211,071, December 17, 1878.
† Consult. U. S. Pat., No. 228,389, June 1, 1880.
‡ Consult U. S. Patent, No. 232,615, September 28, 1880.
§ Consult U. S. Pat., No. 229,274, June 29, 1880.
‖ Consult U. S. Pat., No. 232,755, September 28, 1880.

No. 2.

Double sulphate of nickel and ammonium	10 parts.
Boric acid (refined)	2½ to 5 "
Water	150 to 200 "

(Weston's solution.) The superiority of this solution is generally acknowledged. The deposited metal, as previously remarked, is almost silver-white, dense, homogeneous, and tenacious, and the solution maintains its excellent working quality very uniformly in long-continued service.

The nickel salt and boric acid may be dissolved separately in boiling water, the solutions mixed, and the volume brought up to that of the formula, or the two components may be dissolved together.

No. 3.

Acetate of nickel	2¼ parts.
Acetate of calcium	2½ "
Water	100 "

To each gallon of this solution add 1 fluid ounce acetic acid, 1·047 sp. gr.

To prepare this bath, dissolve about the same quantity of the dry carbonate of nickel as that called for in the formula (or three-quarters of that quantity of the hydrated oxide) in acetic acid, adding the acid cautiously, and heating until effervescence has ceased, and solution is complete. The acetate of calcium may be made by dissolving the same weight of carbonate of calcium (marble-dust) as that called for in the formula (or one-half that quantity of caustic lime), and treating it in the same manner. Add the two solutions together, dilute the volume to the required amount by the addition of water, and then to each gallon of the solution add a fluid ounce of free acetic acid, as prescribed. (Potts' solution.)

No. 4.

Sulphate of nickel and ammonium	10 parts.
Sulphate of ammonium	4 "
Citric acide	1 part.
Water	200 parts.

The solution is made with the aid of heat, and, when cool, small fragments of carbonate of ammonium should be added until the bath is neutral to test paper.

No. 5.

Sulphate of nickel	6 parts.
Citrate of nickel	3 "
Phosphate of nickel	3 "
Benzoic acid	1½ "
Water	200 "

No. 6.

Phosphate of nickel	10 parts.
Citrate of nickel	6 "
Pyrophosphate of sodium	10½ "
Bisulphite of sodium	1½ "
Citric acid	3 "
Aqua ammonia	15 "
Water	400 "

(Powell's solutions.) These solutions yield good results, but their complex composition must debar them from general use.

No. 7.

Sulphate of nickel	6 parts.
Aqua ammonia	3 "
Water	100 "

When the nickel is dissolved, add—

Aqua ammonia	20 parts.

This bath is similar to that recommended by Prof. Boettger; it is said to be well suited for the purposes of amateurs, inasmuch as it gives good results with a platinum anode. It is worked at a temperature of 100° Fah., with a moderate current. It requires renewal from time to time, as it becomes impoverished in nickel, by addition of fresh nickel salt; it must also be kept alkaline by the occasional addition of ammonia.

No. 8.

Sulphate of nickel and ammonium	10 parts.
Sulphate of ammonium	1½ "
Water	250 "

Dissolve in boiling water, and allow to cool. These proportions are recommended for coating objects of cast and wrought iron and steel.

No. 9.

Sulphate of nickel and ammonium	10 parts.
Sulphate of ammonium	2 "
Water	300 "

Dissolve as above. Recommended for coating brass, copper, tin, britannia, lead, zinc, etc.

No. 10.

Sulphate of nickel and ammonium	6 parts.
Chloride of ammonium (sal-ammoniac)	3 "
Water	100 "

Watt* recommends for ordinary purposes the following solution, which he affirms will give in careful hands very good results: "Take say two ounces of pure nickel, dissolve in hydrochloric acid, taking care not to have an excess. A gentle heat will assist the operation. When dissolved, dilute the solution with one quart of cold water. Now add ammonia gradually, until the solution is quite neutral to test paper. Next, dissolve one ounce of sal-ammoniac, (chloride of ammonium) in water, and mix this with the former solution. Lastly, evaporate, and crystallize slowly." The resulting salt will be the double chloride of nickel and ammonium. It is one of the earliest solutions used for nickel plating by Smee and Gore, and is affirmed by these writers to give good results. Watt has also obtained excellent results with the double chloride. According to Smee, the simple chloride of nickel will yield a deposit having a very brilliant luster.

I can unqualifiedly confirm the statement of Gore† that the electro-deposit obtained from a solution of the double cyanide of nickel and potassium is "nearly equal in whiteness to silver." I have obtained deposits with this solution, of such extreme whiteness and beauty as to deceive even an expert on casual inspection into the belief that they were silver. The bath, however, rapidly loses its activity and runs down, and is so difficult to manage that it is impracticable for general use. This, at least, is the opinion I have reached after many trials of it. I am informed, nevertheless, that it is successfully used on the large scale in certain nickel plating works in this country, though I have not been able to substantiate the fact.

* Watt, *Electro-Metallurgy* (7th ed.), p. 94.
† Gore, *Electro-Metallurgy* (1877), p. 283.

To prepare this bath make a solution of any salt of nickel, and add cyanide of potassium solution so long as a precipitate continues to be formed, being careful to avoid adding an excess. Then remove the liquid either by decantation or filtration; and after several washings dissolve the precipitate almost to saturation in cyanide of potassium solution. Make a completely saturated solution and add a small quantity of free cyanide of potassium. The brownish-red solution is then ready for use.

It may be added, in conclusion, that the double sulphate of nickel and ammonium is used most generally by electro-platers with nickel.

GENERAL OBSERVATIONS.

Where the double sulphate of nickel and ammonium is used, it is important that the operator should bear in mind the caution to maintain the bath as nearly neutral as possible. There is a diversity of opinion among nickel platers upon this point, some preferring to operate with a slightly acid bath, while others prefer the opposite condition. Experience has shown that the solution will give satisfactory results either when slightly acid or slightly alkaline, and, as the chemical character of the bath during electrolysis is constantly being modified, it is manifestly impossible for the operator to do more than to keep his solution approximately in the right condition. A strongly acid solution will fail to give a deposit. When the bath therefore is found to be in this condition, the addition of sufficient ammonia to restore its neutrality will bring it to working condition.

It is only by accident or carelessness, however, that the solution will become inoperative from this cause, as the chemical changes which occur in the solution of this salt, under the influence of the electrical current, and under the conditions in which it is commonly used in the plating bath, are such as to cause it to gradually assume an alkaline character. This is due to the fact that not simply sulphate of nickel, but to some extent, also, sulphate of ammonium, undergoes decomposition into its proximate constituents. The sulphuric acid set free by the decomposition of the ammonium sulphate will form an equivalent quantity of sulphate of nickel by solution of the anode, while the ammonia will remain free, and gradually, as it accumulates, will impart a decided alkalinity to the bath. The more intense the current employed, the more rapid will be the decomposition of the solution and the liberation of free ammonia. As this change progresses; the quality of the work is more or less unfavorably influenced. Accompanying this change, especially where the current employed is irregular and at times too intense, there is also a precipitation of some of the nickel probably in the form of basic salt, by which the metallic strength of the bath is impaired, and which necessitates the addition of fresh quantities of the double sulphate from time to time. Where a current of only moderate intensity is used, and which is uniformly maintained, these difficulties will be reduced to a minimum, and the solution will maintain itself in good working order for a long time, requiring only the occasional addition of a little sulphuric acid to correct any pronounced alkalinity that may be exhibited when tested, as it should be at frequent intervals, with test paper. As metallic nickel is difficultly soluble, the use of comparatively large anode surfaces is necessary, because the nickel dissolves so slowly that if the anode surface exposed in the depositing vat is not considerably larger than that of the objects on which the deposit is made, the solution will not keep saturated. There is another reason for the use of a comparatively large anode surface, which will appear further on.

From the preceding remarks it will be unnecessary, perhaps, to add that the double sulphate solution commonly used by nickel platers presents greater difficulties in its employment than the acid solutions of Potts and others.

Again, the strength of the current should be carefully regulated according to the surface of the articles in the bath, as otherwise the work will be apt to "burn;" that is, the metal will be precipitated a dark gray or black deposit, which discolors and renders it useless. This is evidence of a current of too great intensity. To obviate this difficulty, the plan is generally adopted by careful operators of suspending a plate of nickel, presenting considerable surface at both ends of the rod from which the articles are suspended in the bath. By thus diverting the current the "burning" of the work is prevented.

As a general rule, it is well to observe that, other things being equal, the slower the rate of deposition the more adherent and tenacious the coating of deposited metal will be. Where the metal deposits too rapidly, the deposit is apt to be brittle, and to exhibit, especially in the case of a heavy coating, a tendency to split and flake. This is due to the liberation of hydrogen at the cathode, and which is occluded by the electro-deposited metal. To obtain satisfactory results, it is important that the articles should be "struck," that is, receive a uniform coating immediately after they are immersed in the bath. This is an indication that the articles have been properly cleaned, and are in proper condition to receive the deposit, and also that the bath is working properly. After this first layer has been deposited, the subsequent rate of deposition is much slower, for the reason that the deposit of nickel on nickel does not take place as readily as upon a foreign metal, a rule which appears to hold good of all metals.

Nickel solutions are feebler conductors of electricity than those of gold, silver, and copper, which is one of the reasons why its electro-deposition is attended with more difficulties than are experienced with the metals named. On this account, also, it is necessary to employ stronger depositing solutions than those used for gold and silver, and a stronger current. To make up for this want of conductivity it is advantageous to use a much larger anode surface than is customary with other metals, and it is necessary to place an anode on both sides of an article to be plated. The usual arrangement with a large vat is to have two rails of brass the whole length of the vat, resting on the edges of the same, from which two rows of cast or rolled nickel anodes (to which copper wires are soldered) are suspended. Between these outer rods is placed a similar one also running the whole length of the vat, and from this, by means of suitable slinging wires, the articles to be plated are suspended in the bath. The ends of the rails nearest the battery or dynamo are suitably connected therewith in the usual manner. The work thus hangs between the two rows of anodes.

Watt* very properly calls the attention of the operator in this connection to the importance of having the wire sup-

* Watt, *Electro-Metallurgy* (7th Ed.), p. 104, et seq.

ports from which the articles are hung in the depositing vat, of a gauge suited to the character of the work. Small articles will require but a very thin wire, while larger ones will require correspondingly thicker "slinging wires." On the same point he cautions the operator that the difference of conductivity in the metals to be plated is to be considered, "for, whereas, a steel, brass, or copper article would become readily 'struck,' even if suspended from the conducting rod by a thin wire, articles of lead, britannia metal, pewter, or even cast iron would not receive the deposit so readily." It is obvious, therefore, that in suspending articles in the plating bath, the operator must be guided in the matter of the thickness of the "slinging wires" by the nature of the articles as well as by their dimensions.

It cannot be too strongly impressed on the operator that the attainment of success in nickel plating depends very largely upon the perfect cleansing of the articles before they are immersed in the bath. Important as this operation is in plating with other metals, it is even more so in the case of nickel. Gilding, silvering, bronzing, etc., are usually effected with solutions having a decidedly alkaline character (reference is made here to the double cyanide solutions commonly used), and the presence of minute traces of oxide from careless exposure to the air after cleansing, or of grease from the fingers, etc., on the surface of the articles to be plated, is not necessarily fatal to the success of the work, as the free cyanide always present in those baths, being a solvent of greasy substances, and of metallic oxides, may remove trifling quantities of such impurities. With nickel, however, the case is different. The solutions employed for its deposition are either neutral or weakly alkaline or acid. Their chemical character is such, therefore, that they can have little or no solvent effect on the grease or oxide left on the articles by careless cleansing or improper handling or exposure before immersion; and if such articles are plated, the nickel coating at the unclean places will be found to have little or no adhesion to the metal beneath, and will almost certainly flake or strip at these places in the subsequent operation of buffing. Unless the surfaces to be coated are *chemically* clean, an adherent deposit of nickel is simply impossible.

On account of the hardness of the deposited metal, nickel-plated articles cannot be burnished. In order, therefore, to obtain upon the finished work that superb metallic luster which characterizes this metal, it is necessary to polish the surface of the articles upon the buffing-wheel before immersion in the plating bath, in order that the deposited metal may be as smooth as possible; thus reducing the amount of subsequent buffing, required to finish the plated articles, to a minimum.

The operation of cleansing articles differs somewhat in various establishments; the following methods, however, are those usually followed:

For copper, brass, britannia-metal, tin, pewter, etc., the articles are first steeped for a few minutes in boiling potash solution to remove greasy matter; they are then removed, dipped for an instant in cyanide of potassium solution of moderate strength, rinsed in water, again rinsed, then thoroughly brushed with the finest pumice powder (precipitated chalk and other fine powders are also used); again rinsed in water, dipped again for an instant in the cyanide, well rinsed, and then hung at once in the nickel bath. The time of immersion in the boiling potash solution will depend on the strength of the alkali and the amount of greasy matter present. Tin, britannia, pewter, however, should be left in it as short a time as possible, as the alkali exerts a solvent action on tin and alloys containing this metal. When rinsed in water after removal from the potash, the water should wet the surface uniformly; should any cloudy patches be visible, these indicate that the grease has not been completely removed, and the article must be immersed again in the boiling potash.

Steel articles are first treated to the potash bath; rinsed in water, scoured with pumice powder (or its equivalent), rinsed, dipped for a moment in dilute hydrochloric acid, again rinsed, and at once hung in the depositing vat.

Cast iron is first placed in the potash bath to remove greasy matter, well rinsed, then allowed to remain for some time in a pickle of dilute sulphuric acid to partially dissolve off and partially soften the scale that covers it, rinsed, then thoroughly brushed with pumice, rinsed, dipped for a moment in dilute hydrochloric acid, again rinsed and immediately placed in the nickel bath.

Many operators vary the above methods of cleansing somewhat, but they are followed substantially as given by the majority of nickel-platers. With britannia-metal, pewter, and other compositions of comparatively low conductive power, it is to be recommended to give them a preliminary coating of copper, for which purpose the cyanide bath is commonly employed. Many operators prefer also to copper articles of iron and steel preparatory to nickel plating. The advantages secured are a better conducting surface upon which to lay on the nickel, and a more tenacious deposit, having in the case of a heavy coating of nickel less tendency to flake. Where a substantial and durable nickel deposit is required on iron and steel, and especially where the articles are to be exposed to the atmosphere, or will be subject to much handling, a preparatory coating with copper is almost indispensable. In the earlier days of nickel plating it was the almost universal practice to first copper all iron and steel articles.

The enormous extension of nickel plating of late years has caused its application to an endless variety of articles of trifling value merely to enhance their beauty, and this, together with the severe competition among those in the business has combined to cause a very general deterioration in the quality of nickel-plated work. The necessity of doing cheap work is responsible for the fact, therefore, that thousands of articles are turned out of the nickel-plating works with the merest wash of nickel. The want of durability exhibited by these inferior goods has had the consequence that many have formed a low estimate of the utility of nickel as a protective coating for metals, which it is far from deserving.

It is important that the work should be examined very shortly after it has gone into the nickel bath, to observe whether it has been "struck," and its general appearance. Should dark streaks exhibit themselves upon the work, they may indicate either that the current is too intense, or that the work has not been properly cleansed. Such streaks will often be observed, starting from joints, seams, or rivets, where the grease from the buffing-wheel may have secured lodgment, and from which it is difficult to perfectly remove it. In such cases the work must be removed and given another thorough pumice brushing and rinsing, and again immersed in the depositing vat.

As has already been briefly noticed, the hardness of electro-deposited nickel renders it impossible to finish the plated articles by burnishing. It is, therefore, necessary to prepare the surfaces of the articles to receive the nickel deposited before they are plated, in order to reduce the subsequent finishing operations as much as possible. On this account it is customary to polish the surfaces of articles to be plated on buffing wheels. In case the surface is very rough, as is sometimes the case with articles of iron or steel, it may be necessary to grind it smooth upon the emery wheel. The work, when removed from the nickel both, is dipped for a few moments into boiling water, and then rapidly dried in sawdust. It is now ready to be polished on the buffing wheels, when it is finished.

The length of time required to produce a sufficiently heavy deposit of nickel will depend on the strength of the current, the condition of the bath, and the character of the articles. Brass and copper articles usually receive a sufficiently heavy coating in half an hour; for wares on which an extra-heavy coating is desired the time of immersion is extended to an hour or even longer. Iron and steel, britannia-metal, pewter, etc., require a longer time of immersion than brass or copper, even though given a preparatory coating of copper, because of their comparatively inferior conductibility. A good coating of nickel, properly laid on, possesses great durability, and with ordinary usage will last for many years.

Old nickel-plated work which it is desired to replate should first be "stripped," as is found necessary with the precious metals. For this purpose a mixture of sulphuric and nitric acids is commonly employed. Watt* recommends the following mixture, which will be found very serviceable, viz.: "4 pounds strong sulphuric acid, 1 pound nitric acid, and about 1 pint of water." By volume, these proportions would be approximately: Strong sulphuric acid 2 parts, nitric acid 1 part, water 1 part. The acids should be added to the water under constant stirring. This stripping liquid may be used either cold or slightly warm. It acts promptly, removing a light coating of nickel in less than a minute, and a heavy one in a few minutes. To avoid contaminating the solution as little as possible with the metal of the wares, the operation should be closely watched, and the articles removed from the acid just as soon as the nickel has been dissolved. The preparation of the stripped articles for renickeling should be the same as for new work. Articles may be stripped in the nickel bath by the ordinary artifice of connecting them as anodes, but the practice is reprehensible, as the purity of the bath will thereby become impaired by the solution of the metals composing the wares. Where the current is used for the purpose, therefore, a separate solution should be used, and for this purpose Watt's suggestion to use as a stripping solution dilute sulphuric acid, which will dissolve nickel readily without appreciably affecting brass, may be recommended. Under all circumstances, however, the articles should be looked at from time to time, and removed as soon as they are free from nickel. It is important, however, that the old nickel be thoroughly cleaned off to prevent the peeling of the subsequent nickel deposit.

PLATING WITH NICKEL BY IMMERSION.

Stolba† describes the following simple process for nickel plating without the battery, which may be usefully applied in the case of small objects. He dilutes a concentrated solution of chloride of zinc with twice its volume of water. This mixture he boils in a copper vessel, adding a few drops of muriatic acid should there appear a precipitate of basic chloride of zinc. He thereupon adds a small quantity of powdered zinc. This addition causes a deposit of zinc upon the vessel. Thereupon sufficient chloride or sulphate of nickel is added to the bath to give it a distinctly green color, and the previously cleansed articles are then immersed in the liquid in contact with zinc, and allowed to remain there for about fifteen minutes, the temperature being maintained at boiling during the operation. If the coating is found to be insufficient, the articles are again immersed until a deposit of sufficient thickness is obtained. In this way, he claims to be able to coat satisfactorily articles of zinc, cast and wrought iron, steel, and copper.

By an analogous process described by C. Mene,‡ it is affirmed that metallic articles may be plated with nickel by immersing them, in contact with zinc, in a boiling neutral solution or chloride of zinc, in which is contained fragments or a plate of nickel. Should the solution be acid the plating, it is asserted, will be dull. By this procedure the author claims to be able to coat articles of iron, steel, copper, brass, zinc, and lead

Where electrotypes of type or engravings are to be printed with colored inks that are disposed to become chemically affected by contact with the usual copper surface (as for example vermilion, which becomes brownish), it is customary to give the copper electrotype a thin coating of nickel in the usual manner. This nickel renders the electrotype proof against the above named difficulty that printers experience with electrotypes not so protected.

By methods and solutions analogous to those described for nickel, electro-deposits of cobalt may be obtained. The electro-deposits of this metal equal, if indeed they do not surpass, those of nickel in whiteness and brilliancy of luster. The costliness of the metal, however, prevents its use for this purpose.—*Franklin Journal.*

ON A METHOD OF MOUNTING ELECTRICAL RESISTANCES.§

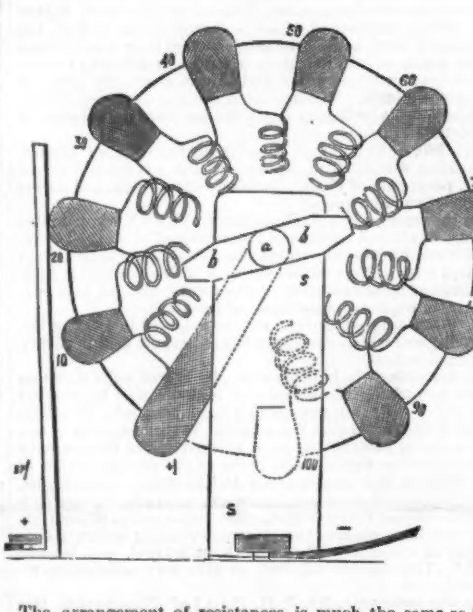
By Arthur W. Waters, F.G.S., etc.

A short time ago I came to the conclusion that there was a strong probability of the variations in the electrical resistances of the human body giving some indication as to how various climatic changes affected different constitutions. This idea forced itself on me in consequence of an investigation concerning the changes of the body temperature, as affected by meteorological conditions, having brought out the interesting fact that the average changes in the 5 to 6 P.M. clinical temperature of a sufficient number of invalids‖ follows the curve of the absolute moisture or of the temperature, both of which are very similar.

Dr. Stone's results, as published in *Nature*, gave a definite direction to the idea, and then, when considering how I could carry out what I proposed, I saw that I must first have an instrument by which measurements could be rapidly made and changes easily followed, and, if possible, the current should not be broken by altering the measure.

The ordinary resistance box with plugs cannot be used sufficiently rapidly, and is unsuitable. I therefore adopted the plan of mounting the resistance reels on an ebonite disk, with a metal axis, *a*, running at each end in brass supports, S. This support has a binding screw at the base, and the current is thus led away from the axis. Round the border of this disk German silver flanges* or bosses are attached, and one of these, *x*, is connected by a stout strip of copper to the axle. Between this and the next boss a resistance coil of fine German silver wire wound double on a small reel is attached, and between each of the other bosses a similar coil is placed, and the two ends severally soldered to the adjoining German silver projection. The disk is revolved by means of a bone or ebonite handle, *b*, and these bosses are thus brought against a strong spring, *s p*, up which the current is led. If the flange connected with the axle is brought against this spring, then there is practically no resistance; but if any other flange is against this spring, then the current must pass through one or more reels of resistance. As figured it would go through two reels of 10 ohms each, and if it went through all the reels we get a total of 100 ohms. As arranged, one boss does not leave the spring until the next is in contact.

The complete instrument consists of four such disks similarly mounted and put into connection, and on the first disk the reels are 1 ohm, on the second 10, and on the other two 100 and 1,000 respectively, so that they are read off like a gas meter, and thus a resistance from 1 ohm to 11,110 ohms can be read directly; and by mounting the commutator and the permanent arms of the Wheatstone bridge on one board, we get a very compact instrument, and have all the handles within easy reach for rapid change. About 7 centimeters will be found ample for the diameter of the disk, and the whole apparatus may be mounted on a board about 45 centims. long and 10 centims. wide.



The arrangement of resistances is much the same as in slide resistances, and the plan of arranging these in a circle has been used for medical purposes, but I am not aware of the resistances themselves being made to revolve, though I have not had any opportunity of investigating all the plans previously adopted. It seems to me, however, that, in cases where only amateur or imperfect workmanship is available, this will be found the simplest plan, and also I think that when compactness and rapidity of action are important this form may often be found useful, and, therefore, describe it, although there is no new principle involved.

One such disk may also be used when a galvanic current is being applied for medical purposes, in which case the current is made to first pass through a high resistance of several reels, and then without contact being broken the resistance is brought down to null. In such cases it may be found advisable to make the first resistance much lower than the last.

* These flanges overlap on each side, and therefore present to the spring a continuous surface the width of the disk.

LIQUEFACTION OF HYDROGEN.

By S. Wroblewski.

The author subjected hydrogen to a pressure of 100 atmospheres in a glass tube, arranged perpendicularly, of 2 mm. external diameter, and of 0·2 to 0·4 mm. internal diameter. By means of a screw the compressed gas can be released instantaneously. The tube was surrounded with liquid oxygen and refrigerated by means of a series of ebullitions of this body. At the moment of releasing the hydrogen there appeared in the tube an ebullition quite analogous to that observed by M. Cailletet in oxygen in his experiments in 1882.

The phenomenon is produced in the same manner at a certain distance from the bottom of the tube. It lasts for a much shorter time, is less decided, and much less easy to perceive. The reason of this difficulty may perhaps be explained by the very low density of liquid hydrogen. MM. Cailletet and Hautefeuille, in their researches on the densities of oxygen, hydrogen, and nitrogen liquefied in presence of a liquid without chemical action upon these elementary bodies, have inferred for liquid hydrogen the number 0·033. Since the same method yielded, under the same conditions, the number 0·89 for the density of oxygen, and since this latter number agrees entirely with the author's direct determinations, it may be admitted that the density assigned by MM. Cailletet and Hautefeuille for hydrogen will not be far from the truth. On the other hand, gaseous hydrogen reaches this same density, 0·033, at a low temperature, under inconsiderable pressures. Hence arises the optical difficulty of distinguishing the liquid from the gaseous portions of the hydrogen. This difficulty has probably prevented the author from reproducing M. Cailletet's experiment on hydrogen. The analogy between the phenomenon described and those presented by oxygen permits us to suppose that the temperature necessary for the complete liquefaction of hydrogen is not far from that which may be obtained by means of boiling oxygen.

* Watt, *Electro-Metallurgy* (7th Ed.), 114, *et seq.*

† *Journal Chemical Society*, xi., 485.

‡ *Chemical News*, xxv., 214

§ A paper read before the Manchester Literary and Philosophical Society, January 22, 1884.—*Chem. News.*

‖ The measurements were made for the purpose by consumptive people in Davos.

WOUNDS AND MUTILATIONS OF WORKINGMEN'S HANDS.

DR. F. GUERMONPREZ has attentively examined a series of wounds, etc., inflicted by implements and machinery upon the hands of workingmen; especially has he studied those received by workers in wood and spinning.

Fig. 1.

Fig 2.

Wounds from piercing—puncture—come from nails, splinters, and the teeth of instruments fitted into handles. Cuts are received principally upon the hands from scissors, hatchets, blades. Circular saws or steel ribbons make deep, sudden, extended incisions, which cause a momentary surprise. Sometimes the saws throw out wooden fragments

FIG. 3.

FIG. 4.

which inflict some injury. Planing machines cause less mischief, and the wounds resemble those produced by tearing; they cicatrize more quickly than contusions, do not interfere long with the patient's activity; the parts unite "by first intention."

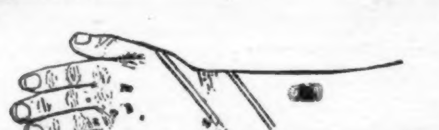


Fig. 5

Examples are given of wounds or amputations in the subjoined figures caused by circular saw (Figs. 1 and 2).

Fig. 3 illustrates a similar though more serious amputation, and Fig. 4 a mutilation caused by a plane.

In the manufactories of the North of France, out of 120

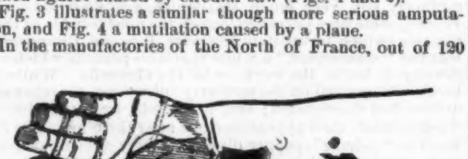


Fig 6

traumatic accidents 78 were finger and hand mutilations. The combs of spinneries seldom inflict injuries; the most serious of these latter are great rents, tearing away of blood vessels, laceration of nerves, opening of articulations, and the introduction of foreign bodies into the osseous tissues.

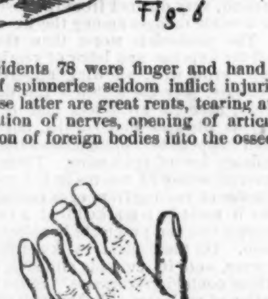


Fig 7

Examples of injuries inflicted by the steel combs are shown in Figs. 5 and 6, where oblique and parallel lines indicate the deep raking of the surface and tissues beneath. Fig. 7 represents a distortion also produced by contact in the wires of a comb.—*Journal d'Hygiene.*

DANDRUFF: WHAT IT IS, AND HOW TO CURE IT.

By GEORGE T. JACKSON, M.D., clinical assistant to the chair of dermatology, College Physicians and Surgeons, attending physician to the Demilt Dispensary (skin department), etc.

THE term dandruff, or dandriff, has often been very loosely used to designate at least four distinct diseases of the scalp, namely: pityriasis simplex, seborrhœa sicca, eczema erythematosum or squamosum, and psoriasis, and it is probable that a fifth disease has been included under it, namely, a diffuse trichophytosis capitis. Properly speaking, its use should be limited to that scaly condition of the head which is due to seborrhœa sicca or pityriasis simplex.

Whether these latter two diseases are identical or not is still an unsettled question. By the majority of the German systematic writers they are regarded as one and the same disease, but they present enough points of difference to entitle them to separate consideration. I have here placed them together for convenience, as they give rise to a somewhat similar condition of the scalp, and are amenable to the same treatment. To draw the line sharply between the two is sometimes exceedingly difficult.

Seborrhœa sicca is a functional disease of the sebaceous glands in which an abnormal amount of sebaceous matter of abnormal consistence is secreted by them. This dries upon the scalp, and either appears in the form of thin, fatty plates about the mouths of the hair-follicles or adheres to the hairs in flakes, or, if of more pronounced nature, heaps up into thick, fatty masses or cakes, which cling with a good deal of tenacity to the scalp. This latter form is seen very frequently in children during the early months of infancy. If portions of these crusts or cakes are rubbed between the thumb and finger, they will impart an unctuous feeling. The scalp in this disease is usually pale or leaden-hued, and when the crusts are removed shows no tendency to moisture, or else exhibits a fatty, glistening surface upon which the crust is soon renewed. In some cases more activity is shown, and the scalp is hyperæmic. The affection runs a chronic course, is generally quite uniformly distributed over the whole head, but in some cases it is confined for the most part to the edge of the hair over the forehead and to the vertex of the head. Some pruritus at times is present, and sometimes, in consequence of scratching, there will be excoriations. When we have the head covered with thick, fatty crusts which give an unctuous feeling when rubbed between the thumb and finger, and upon being removed leave the scalp pale, there will not be any difficulty about the diagnosis. But in those cases in which only a few dry scales are present and the scalp is slightly hyperæmic, our decision as to the disease cannot be so readily given.

Pityriasis simplex or *capillitii*, is essentially an interference with the cornification of the upper cell-layers of the skin, on account of which, instead of the normally compact stratum corneum we have a constant shaling off of the imperfectly formed epethelial scales. The whole scalp may be quite uniformly affected, or the disease may be limited to the vertex, or it may occur in circumscribed patches. The scales are thin, easily detached from the scalp, sometimes so easily as to be readily blown off, and they do not pile up into crusts. When rubbed between the thumb and finger, these scales do not impart the same unctuous feeling as do those of seborrhœa sicca, though there is usually a certain amount of sebaceous matter present, as in seborrhœa sicca there is always an admixture of epithelial scales. More or less hyperæmia is usually present, though in some cases the scalp is of normal color. There is never any moisture of the scalp. Pruritus often annoys the patient, especially when he is overheated or is using his brain actively, and this inviting scratching, excoriations are often met with.

These two diseases, differing mainly in their essential lesion and constituting dandruff, cause annoyance by the constant falling of the scales upon the shoulders of the patient, ruining the clothing or giving it the appearance of being powdered, and by the pruritus which attends them. It is for these reasons, in most cases, that the patients apply to us for relief. But dandruff is in many cases the forerunner of baldness, and the fact that a long continued seborrhœa sicca, or pityriasis, is the most frequent cause of premature alopecia should stimulate us to use our best efforts to cure the disease.

Causes.—Dandruff frequently occurs in strumous individuals who are anæmic and have a sluggish circulation, marked by cold hands and feet. Adolescence is its peculiar time of appearance, and chlorotic young girls are apt to be annoyed by it. It is an attendant upon chronic debilitating diseases, as rheumatism, syphilis, phthisis, and the like, and comes on after profound disturbances of the constitution, such as fevers and parturition. Dyspepsia and constipation are very common exciting causes or aggravants of the disease. Improper care of the scalp, the use of the fine-toothed comb, and of pomades, hair "tonics," and hair-dyes will give rise to the disorder. In some cases there is apparently no cause for the disease, but careful inquiry, even in these cases, will usually bring out some latent cause, such as worry, overwork, mental or nervous strain, and the like. Malassez, Thin, and some others claim to have found a parasite as the origin of the trouble, and recent experiments by Lassar and Bishop would seem to prove that the disease, at least pityriasis simplex, is contagious. These investigators (Lassar and Bishop) took the hair and scales from the head of a healthy German medical student, made a pomade by chopping them up and mixing them with vaseline, and rubbed it into the back of a guinea-pig and of a rabbit. In the course of three weeks these animals presented an appearance similar to that of the student. The experiment was twice repeated, using the hair and scales from the first and second pair of animals respectively, and with like result.

Diagnosis.—Before we can intelligently treat a case of scurfiness of the scalp we must arrive at a correct diagnosis, and must differentiate between dandruff on the one hand and eczema, psoriasis, and diffuse trichophytosis capitis on the other.

Eczema is distinguished by the scales not being so abundant nor so greasy as in dandruff; by their being more parchment-like, as if formed rather of dried serum than inspissated fat; by the disease not being so diffuse but more limited to certain patches, or to one side of the head, and implicating contiguous non-hairy parts; by the greater amount of hyperæmia; by the moisture which is either present or readily induced by scratching; by its being far more pruriginous, and by its history. If thick crusts are present, they will usually be of a greenish-yellow color, and when removed will expose a reddened oozing surface.

Psoriasis rarely occurs upon the scalp without being found on other parts of the body. It occurs in the form of circumscribed round or oval reddish infiltrated patches, which if of large size are seen to be composed of a number of smaller round patches which have joined together at their edges. These patches are covered with a thick mass of grayish or white glistening scales which are not greasy, and on being removed expose a number of minute bleeding points or red dots, and do not reform as quickly as those of seborrhœa. The disease tends to form a fringe under the hair on the forehead, and sometimes to push its white, glistening, scaly surface down upon the forehead, and often presents a patch just in front of the ear.

Trichophytosis capitis (tinea tonsurans), when occurring as a "ring-worm," should offer no difficulty in diagnosis, its circular shape and the presence of broken and gnawed-off hairs being pathognomonic. The diffuse form is rare, and is to be diagnosed by its history of gradual spread from numerous reddish points or papules, by its scales not being greasy, by the hair being broken off and fragile, and by the microscopical examination of the hair and scales, which will reveal the trichophyton fungus in abundance.

Besides these three diseases, lupus erythematosus may sometimes call for differentiation. It is rarely met with upon the scalp, and then occurs in the form of a sharply defined patch with an infiltrated reddened base covered by a thin adherent scale, which being raised shows on its under side a number of prolongations, the sebum plugs withdrawn from the follicles. The disease causes loss of hair and well-marked atrophic changes in the scalp.

Treatment.—A good deal in the way of preventive treatment of dandruff can be accomplished by the proper care of the scalp and of the general health. More care than is usual should be bestowed upon the operations of brushing and combing the hair, washing the scalp, and upon the selection of the brush and comb. The brush should be composed of bristles well set into the back. The bristles should be placed in little clumps at regular distances and rather far apart, and those in each clump should be of unequal length and arranged so that the longest ones are in the center of the group. It is well to have two brushes, one stiff enough to warm the scalp when used with vigor, and one quite soft. The comb should be made with large teeth set wide apart. When held up to the light the teeth should show no roughness or inequality of surface. The fine-toothed comb should be banished from the toilet-table, as it is an active agent in producing inflammatory conditions of the scalp, as many a case of eczema capitis in children will testify. In the morning the hair should be thoroughly opened up in all directions with the comb, and it and the scalp brushed vigorously with the stiff brush. Then the stiff brush should be laid away for the day, and the soft one used in parting the hair, in polishing it, and in subsequent brushings during the day.

Do not wash the head too much. I believe that the so-commonly practiced daily sousing of the head in water is hurtful to the hair and scalp, especially if they are not carefully and thoroughly dried afterward, and a little oil or vaseline rubbed into the scalp. It is not the daily sousing which is objectionable, but the insufficient aftercare. Water renders the hair dry, and the daily sousing only washes the head superficially. A good shampoo every week or ten days for those persons exposed to a good deal of dust, and every two or three weeks for other people, is sufficient for cleanliness. For the shampoo, soap and water, borax and water, or one composed of the yolk of an egg beaten up in lime-water, are all simple and good, but it must not be forgotten to wash out these materials with plenty of clean water and to thoroughly dry the hair and scalp.

Patent hair "tonics," pomades, washes, and dyes are to be avoided. Those containing grease—pomades—are, to use an Anglicism, "nasty," give the hair an unnatural luster, smear the hat-band and whatever the hair touches, and becoming rancid act as local irritants. None of these dressings are needed by the healthy scalp, and the proper care of the scalp as above indicated will preserve the hair in better condition than they will.

The nearer the body can be kept to the standard of perfect health by means of bathing, exercise, and good diet, the less likely is dandruff to develop. When, therefore, the disease has appeared, and we are applied to for relief, one of our first inquiries should be concerning the general health, and our first efforts addressed to remedying anything found to be wrong. For important as our local measures are in relieving the local disorder, in most cases we must depend upon internal treatment to render the cure permanent. The internal treatment must be along the lines marked out in works upon general medicine—tonics, as cod liver oil and iron, for the debilitated; the acids and bitters for the neurotic and dyspeptic; mercurials, podophyllin, and the like for the bilious, etc. Duhring recommends sulphur and the sulphide of calcium as of especial efficacy, and arsenic sometimes acts well. We should insist upon our patient obeying the laws of general hygiene, and instruct him in the above or similar rules as to the proper care of the scalp.

Various substances, all of a more or less irritating nature, have been recommended for the local treatment of dandruff. Such are tincture of cantharides, ʒj–℥j; tincture of capsicum, ʒj–℥j; tincture of nucis vomicæ, ʒj–℥j; chloral, ʒj–℥j; bichloride of mercury, gr. ij to iij–℥j; the oleate and other mercurials in proportionate strength; sulphur, ʒj–℥j; carbolic acid, gr. x to xx–℥j; quinia, strychnia, etc. These have been given either in solution in alcohol, water, or the oils of olive, castor, rosemary, sage, etc.; or as ointments. A good menstruum for their exhibition is composed of glycerine, ʒj–ij, to dilute alcohol, ℥j. Vaseline forms the best medium for their exhibition as ointments. Excepting where the hair is decidedly thin, so stiff an ointment as the ungt. zinci. oxid. should not be used, and lard itself is apt to become rancid.

Of all the above remedies, I have been led by experience to place my main reliance upon sulphur and the mercurials, and would advise the following plan of local treatment. If the case presents itself with a decided accumulation of scales, or if crusts are present, direct the patient to saturate his head with oil, preferably sweet almond oil, before going to bed, and to place over his head a flannel cloth soaked in the oil, and outside of all an oiled silk cap. The next morning he should shampoo his head thoroughly with soap and water, using by preference the tincture of green soap, and wash out the soap with plenty of water. The scalp is then to be dried by vigorous rubbing with a coarse towel, and the hair by pulling it through a soft towel. If the crusts by this method are not completely removed, the oil should be kept on during the day, the head again soaked at night, and washed with the soap and water in the morning. If the scalp should appear very hyperæmic after the crusts are removed, anoint the head with vaseline or

some simple ointment, as rose ointment, until the hyperæmia is lessened. When the crusts are removed and the hyperæmia overcome, have an ointment composed of one drachm of sulphur loti to one ounce of vaseline applied every morning to the scalp. If the scales form rapidly, apply the every night and the sulphur ointment every morning, and wash the head every second or third day. As soon as scaling is lessened stop the use of the oil, but continue the ointment, at first using it every second morning, then gradually reducing its application to once a week. Throughout this plan of treatment the head should be shampooed about once a week with the tincture of green soap, borax and water, or the yolks of three eggs beaten up in one pint of lime-water, to which a half ounce of alcohol is added. Another excellent ointment for these cases, for the formula of which I am indebted to Prof. Bronson, of the New York Polyclinic, is composed as follows:

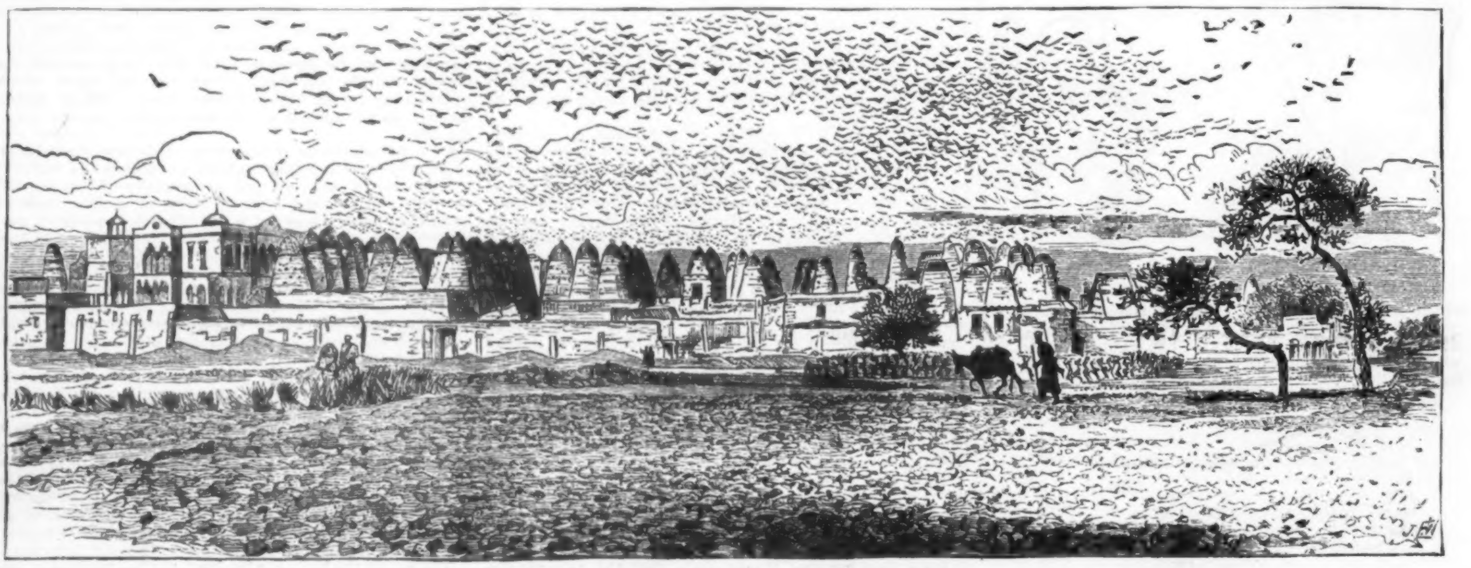
℞. Hydrarg. ammon.	gr. xx.
Hydrarg. chlor. mitis	gr. xi.
Petrolati	℥ j.

This applied once or twice a day has yielded most admirable results in a number of cases of simple dandruff. Its consistence being that of a Mayonnaise dressing renders it an elegant pomade for private practice. Its use should be combined with the occasional shampoo as directed above.

The persistent and systematic use of either of these two plans of treatment, together with a proper oversight over the general health, should cure every case of dandruff. But we should be prepared for occasional relapses, and not give our patients promise of too speedy a cure.—*Medical Record.*

EGYPTIAN PIGEONS.

A CURIOUS feature of rustic scenery in most parts of Egypt is the multitude of pigeon-houses attached to almost every village and to the suburbs of towns; the agriculturists being led to cherish the breeding of these familiar birds in great number for the production of a most valuable manure which is almost identical with guano. Pyramids or cones of dried mud, surmounted by domes pierced with a number of deep cavities like the cells of a bee-hive, are built for their special accommodation; and they are permitted freely to pick up their food in the neighboring fields of grain. It must be presumed that they repay their cost, if not by adding to the native fertility of the soil, at least by the sale of them, now and then, in the city markets, where poultry of all kinds fetches a tolerable price. Our artist, says the *London Graphic* has sketched a "city of pigeons," just outside the walls of Cairo, which has a very singular appearance.



A CITY OF PIGEONS NEAR CAIRO.

NOTES ON THE REARING OF SILK-PRODUCING BOMBYCES IN 1883.

By ALFRED WAILLY (Membre Lauréat de la Société Nationale d'Acclimatation de France).

General Remarks.—By referring to my report on the rearings of 1882, which appeared in four numbers of the *Journal of the Society of Arts* (19th and 26th January, and 2d and 23d February, 1883), it will be seen that during the very mild winter of 1881–1882, a considerable number of moths emerged from cocoons of Indian wild silkworms. During the last winter only six moths emerged from the 1st to the 16th of January, 1883, after which no more emerged till May. As I have observed, and stated in previous reports, moths from tropical species are apt to emerge during the winter when the weather is mild, while moths of native or northern foreign countries seldom, if ever, emerge before the spring. This irregularity in the emergence of the moths of tropical species is one of the difficulties in the way of their reproduction and acclimation; it may take place at any season, though the greater number emerge in the summer and autumn. Hence the necessity, to have a fair chance of success, of having a large number of live cocoons.

I bred, or attempted to breed, in 1883, about the same number of silk-producing bombyces as in previous years, such as *Attacus Pyri*, of Central Europe, *Attacus Cynthia*, and *Antheræa Pernyi*, originally imported from North China; *Telea Polyphemus, Samia Cecropia, Samia Promethea, Saturnia Io*, and *Actias Luna*, from the United States of North America; *Actias Selene* and *Antheræa Mylitta*, from India. *Attacus Atlas*, as will be seen further on, could not be attempted. I reared, besides the above-named species, a number of lepidoptera, which, as they have no connection at all with sericulture, cannot find their place here. My notes on the rearings of 1883 being very numerous, covering some 28 pages of my note book, I shall not produce them *in extenso*, as details on most species have already been given in previous reports. Although it is sometimes necessary to repeat former statements, I shall confine myself principally to new facts.

As yet, only a few of my European and American correspondents have sent reports of their success or failure in rearing the various species of silk producers. Of British correspondents, Mr. John Ball, of Macclesfield, has obtained a very great success in 1882 and 1883 with *Antheræa Pernyi, Actias Luna*, and *Actias Selene*, and he wishes me to record it. With respect to the rearing of *A. Pernyi*, in 1882, Mr. Ball says he found this most valuable silkworm as easy to rear as any of the British lepidoptera, and quite hardy, and he succeeded in obtaining two broods during the year. The moths began to emerge from the 1st of May, and the first larvæ hatched on the 16th of the same month; the larvæ spun up from the 20th to the 24th of June. On the first of August a female moth emerged, and on the 3d a male, from the pairing of which ova were obtained on the 4th, which hatched on the 16th of August. Larvæ formed their cocoons from the 1st to the 7th of October.

Of *Actias Luna* reared in 1882, Mr. Ball says: With the 24 ova you sent me I obtained 22 larvæ, four of which died in first stage. The other larvæ thrived splendidly; they had batched on the 15th of June from ova laid on the 2d of June. The larvæ spun up from the 13th to the 17th of July. From the 18th of August to the 22d all the moths emerged from the cocoons, and all were fine, perfect speeimens. In 1882, Mr Ball was equally successful with this species, the rearing having taken place about one month later.

With respect to *Actias Selene*, Mr. Ball says: The larvæ from the ova you sent me on the 8th of July, hatched on the 15th of July, spinning up from the 18th to the 19th of August, and the moths emerged from the 21st to the 24th of September. Mr. Ball's rearing of *Selene* in 1882 was also a great success; it took place at the same period, the moths emerging from 21st to 25th of September, all splendid specimens. Both *Luna* and *Selene* were fed exclusively on walnuts.

WILD SILKWORMS.

Of late years, wild silk culture has attracted much attention in various quarters, and there is no doubt that the rearing, on a large scale, for commercial purposes of such silkworms as *Pernyi, Cynthia, Mylitta* (tussah), *Polyphemus, Cecropia*, and others, would be a very profitable enterprise, if these wild silkworms were bred in climates suitable both to the worms and the plants they feed upon. These two indispensable conditions could easily be found. *Attacus Cynthia* is not only acclimated but naturalized in France, and it can be reared even in England, in the open air, with the greatest success. *A. Pernyi* (oak silkworm) can also be reared in the open air, and it is reared, on a large scale, in Guipuscoa, a northeastern province of Spain, where two crops of cocoons are obtained every year. *Telea Polyphemus*, introduced by me in this province, thrived equally well, and became acclimated. Some years ago, I sent large quantities of *Cynthia* and *Pernyi* live cocoons to the United States of North America, and both species are now found wild in many parts. The acclimation of these wild silkworms is, therefore, an easy matter when a suitable country is chosen.

I lately received from Paris a letter dated 31st October, from a gentleman who, together with some of his friends, intend to intrust a rather considerable capital to one of my correspondents in French Guiana, for the purpose of cultivating on a large scale the *Attacus Aurota*, a wild South American silkworm common in Brazil, the Guianas, and other parts of South America. No doubt, if the project is carried out, the rearing of this species will be easy, and the quantity of cocoons obtained will be enormous, for this silkworm has six generations every year in French Guiana. But I was asked before anything was done respecting that enterprise to give advice, and state what would be the commercial value of the silk, which was a difficult question to answer.

Cocoons, as is well known, are of two sorts: the closed cocoons, like those of *Pernyi, Yama-Maï, Mylitta, Polyphemus*, and others, and those cocoons which are naturally open at one end, such as those of *Cynthia, Atlas, Cecropia, Aurota, etc.* The *open* cocoons, and *Aurota* is one of them, remain exactly the same after the moth has emerged as they were before, and no opinion on the quality of the silk can be formed till these cocoons have been carded. The *closed* cocoons, on the contrary, are cut open (or are apparently *cut*) by the moth when it emerges from it; then the threads can be pulled, and the silk examined and appreciated to a very great extent. Such is not the case with the open cocoons, the silk of which cannot be pulled by hand.

For the last ten years my work has been the reproduction, rearing, and study of the various wild silkworms of China, Japan, India, and America, of which I could obtain live cocoons or ova. Many persons in Europe and America, through my exertions, have also been able to rear and study them. But this work has occupied all my leisure hours. I have had, therefore, no time left to study the quality of the silk of the various species. All I know is that the silk of *Pernyi, Yama-Maï*, and *Mylitta* is valuable, and, if well worked, is almost equal to that of the *Bombyx Mori;* the silk of *Polyphemus* seems equally fine. I had always thought, and I still think, that the silk of these species, with closed cocoons, is superior to the silk of those with open cocoons, and my opinion also was that reeled silk was of more value than carded; but from a letter lately received from Mr. T. Wardle, of Leek, a great authority on such a subject, I see that carded silk is as good as reeled silk, a very important fact to know, as it would make some of the open cocoons as valuable as the closed ones, if the thread obtained by carding were as fine as that obtained by reeling. In his letter of the 5th or November last, on the subject of sericulture, Mr. T. Wardle says: "Have you visited No. 71 New Bond Street, London, where all my Tussur (*Mylitta* or *Paphia* of India) developments are? My partner, Mr. Brough, would be glad to explain anything to you. I think, if any one went to India to collect Tussur cocoons and any other wild silks, that it would pay, and I think any enterprise of that kind would receive some Government encouragement. . . . To cultivate any cocoons would be a good speculation, if they could be produced in sufficient quantity, because, if they cannot be reeled, they can be carded, and of the two, there is more demand for carded yarn than reeled, and a carded yarn fetches more money than a reeled one."

I twice visited Mr. Wardle's place in New Bond Street, and I examined with the greatest interest the splendid and various articles manufactured with the Tussur silk, and I would recommend all persons taking an interest in this subject to visit the place. A visit to Mr. Wardle's would show of what importance would be the cultivation, on a large scale, of the Tussur and other equally valuable wild silkworms in such countries as would be suitable to them.

The collecting of wild silk cocoons in the forests of India, or other parts, would be profitable to reproduce and rear the various species, but I do not think sufficient quantities of these cocoons could be collected in this way for manufacturing purposes, and for the latter, rearing in the open air and on trees must be resorted to.

Worms reared in a state of domesticity in warm rooms, or in "*magnaneries*," as the mulberry silk worm, would be liable to the terrible contagious diseases which for years have attacked the latter, to such an extent as to make the supply of mulberry silk very much smaller than it used to be. In France, some fifty years ago, one of the most terrible of these diseases (which fortunately has now, it is said, disappeared) was the "*muscardine*," a white vegetable parasite which was developed inside the worm or in the chrysalis. While the *muscardine* preyed on the mulberry silkworms, the other epidemics had disappeared; but, from 1845, two other distinct diseases made their appearance one after the other. The first was the "*pébrine*" (pepper disease), a very ancient affection of the worms, which, when attacked by it, are covered with black spots, and grow smaller and smaller till they die. Later on, a second, very distinct from the first, and a worse disease, made terrible ravages among the worms; this is the "*flacherie*." The *flacherie* is worse than the *pébrine*, because, after all the expense and labor of rearing the worms, which eat and grow well, showing apparently no signs whatever of disease, they die within a few days before the spinning period; hence, a great loss and disappointment. These contagious diseases may coexist, but when they are intense, it often happens that one excludes the other, according to the ordinary law of epidemics. These diseases, created by the overcrowding of worms in hot rooms, may also be the consequence of rearing from eggs containing the germ of disease, for it must be remarked that a certain number of diseased worms live and procreate in spite of that germ of disease in them. On the contrary, silkworms reared in the open air, on trees, and in suitable climates, could not be attacked by these contagious diseases. Since the deficiency in the production of mulberry silk, the cultivation in India of the Tussur silkworm has been considered of the highest importance. As yet, it does not seem that the rearing of the Tussur worm has been attempted on a large scale, though, no doubt, it will be so before long.

Major G. Coussmaker published, in 1878, a most useful and interesting pamphlet on "The Tussur Silkworm," and every year, in spite of the difficulties in his way, Major G. Coussmaker reared this valuable silkworm in a state of semidomestication in the neighborhood of Poona, with a success which increased every year, as may be seen by reading his annual reports. In his last report to the Secretary of the Bombay Government, dated Poona, 14th February, 1883, previous to his final departure for England, Major Coussmaker, however, says that he regrets he cannot recommend Government to continue these experiments in that part of India, owing to three causes, the principal one being that the climate there was an insurmountable obstacle.

On a visit I paid to Major G. Coussmaker last October, I had the pleasure to converse with him at length on the subject of sericulture in India, and I have since read the many letters which were sent to him on the subject by correspondents in various parts of India. A perusal of these letters shows that the rearing of the Tussur silkworm could be successfully carried out on a large scale, if assistance were given to an experienced sericulturist.

From the knowledge acquired by the reading of numbers of reports and letters, I think that a warm, moist temperature, such as that of Ceylon, is the best for the Tussur and some other wild silkworms.

I have also examined Tussur cocoons sent from Calcutta, Madras, Ceylon, and Bombay, the last having been kindly brought for me by Major Coussmaker. Major Coussmaker complains in his last report of the small size of the Bombay cocoons, as compared with those of other parts of India. Now, those from Ceylon are quite as small, if not smaller, than the Bombay cocoons, but the silk of the Ceylon cocoons, in my opinion, is finer and softer; they are for the most part of a yellowish white, and similar in shape and texture to the Japanese oak silkworm (*Yama-Maï*) cocoons.

In January, 1883, I saw in the offices of the Societe d'Acclimatation de France, in Paris, cocoons which had been sent when alive from Cochin-China. These cocoons seemed to me exactly like those of the Ceylon Tussur in size, shape, and color; but the moths varied in their shades of color, just as those of the Tussur found in various parts of India. The moths of the Ceylon species, on the contrary, as far as I have observed, are all of the same color, the male being dark reddish brown, the female bright yellow. An interesting article on the Cochin-China silkworm, which I saw in Paris, written by M. J. Fallou, may be read in the June number, 1883, of the "Bulletin" of the Societe d'Acclimatation. The species was at first considered as being *Antheræa mylitta* (the Indian Tussur), but subsequently it was found to be *Antheræa Frithii* (Moore), a species described in the "Proceedings of the Zoological Society," 28th June, 1859.

By comparing the species which I have considered as the Ceylon *A. mylitta* with the other Indian *Mylitta*, an entomologist might be led to give the Ceylon race a different name than *Mylitta*, as the cocoon is more oval and somewhat different in other respects, and so are the moths to a certain extent.

But, is it not possible that these differences are due to a difference of climate, and that the Ceylon species and *A. Frithii* are only southern species or varieties of *A. mylitta?* At any rate, whether or not the Ceylon silkworm is the same species as the *A. mylitta* of the more northern parts of India, it seems evident that the moist and warm climate of Ceylon is very suitable to the rearing of that species of *Mylitta*. In all probability other species would succeed as well, and the introduction of the more northern *Mylitta* into Ceylon would, in course of time, show whether it is the same as the Ceylon silkworm.

Coming now to the rearing of the *A. mylitta* and other wild silkworms in various parts, and on a large scale, the plan adopted by the Japanese for the rearing of their valuable oak silkworm, *Yama-Maï* and very probably also by the Chinese, who are expert sericulturists, might be followed. Many papers have been written on the culture of the Japanese *Yama Maï*, two published as far back as 1864, one of which had been translated from the Japanese into Dutch, by Dr. Hoffman, and then from the Dutch into French, by M. F. Blekman, interpreter to the French Legation in Japan. According to the pamphlet translated from the Japanese, the plan adopted for the rearing of the *Yama-Maï* consisted of three different operations. I say "consisted," because the first and second systems of rearing may, perhaps, not be adopted at the present time. Now, let us see what these three systems of rearing the *Yama Maï* are:

1. On branches, *en baquets*, in tubs.
2. On branches, *a fleur de terre*, at a level with the ground.
3. On trees, *en libre nature*, in the open air.

A note following these three headings says: The first mode is employed for the rearing of the worms till after the third moult; after that period the second and third modes become applicable.

The first mode of rearing is this: Tubs, placed under a shed, are filled with water and covered with lids in which holes have been bored, four, five, or six, according to the size of the tubs. The oak branches which are to feed the worms are plunged through these holes into the water, taking care to plunge the stalks of the branches into the holes which are opposite to one another, using only half of them, and corking or stopping the holes which have not been used, till the foliage has been eaten by the worms, or has become too old or faded. Then fresh branches are introduced into the tubs through the holes left vacant for that purpose. The fresh branches being placed so as to touch the old ones, the worms quit the old branches to go to the fresh ones. If the space is too wide between some parts of the old branches and the new ones, the old branches are cut in small pieces, which are placed or pinned on the new branches. A tap is placed at the lower part of the tub, so that the water can be drawn out and renewed every other day, or every day, as the purity of the water is of the utmost importance. This plan of rearing may be adopted till the worms form their cocoons, when the rearings are on a small scale.—*Journal of the Society of Arts.*

GENERAL TRUTHS IN APPLIED ENTOMOLGGY.*

By C. V. RILEY.

MR. PRESIDENT and Gentlemen of the Georgia State Agricultural Society:

On your programme I am booked for an essay on "Insects Destructive to Southern Agriculture." Your worthy Secretary, Mr. Grier, is responsible for that title, for I had no idea of what it was to be till the circular was received on the very day of my departure from Washington. In the mean time, in pondering the question what to present to you, I concluded that it were better, perhaps, to state some general truths of universal application than to attempt to treat of the different species of injurious insects—which the members of this Society must be interested in, coming, as they do, from all parts of a State with such vast and varied agricultural interests. Hence the hasty notes which I shall present are not worthy to be called an essay, and if they must have a title, would better reflect some "General Truths in Applied Entomology." It will, however, afford me great pleasure at the close to give more specific information in answer to any questions that may be asked.

Insects play a most important part in the economy of nature. The average townsman, whose knowledge of them is confined to certain lectual and household pests, can scarcely appreciate the fact or have any other feeling than repugnance and contempt for the annoying hexapods of his acquaintance. Yet, as scavengers, as pollenizers of our flowers and fruits, or as food for other animals, they not only vitally concern man, but, philosophically considered, are seen to be essential to his very existence.

We receive also some direct benefits from insects. They supply us with the sweetest of sweets, our very best inks and dyes, and our finest robes and tapers, to say nothing of various acids, lace, and waxes; while few who have not studied the subject have any just idea of the importance of insects and their products as articles of human diet.

But the benefits, whether direct or indirect, which man derives from insects must always appear trifling compared to the injury they inflict on our agriculture.

In the primitive condition of the country, as the white man found it, insects doubtless took their proper place in nature's economy, and rarely preponderated in any direction to the injury of the wild plants scattered for the most part sparsely throughout their range. Harmony between organisms in the sense of the widest interrelation and interdependence had resulted in the long course of ages. But civilized man violated this primitive harmony. His agriculture, which is essentially the encouragement and cultivation, in large tracts, of one species of plant to the exclusion of others which he denominates weeds, gave exceptional facilities for the multiplication of such insects as naturally fed on such plants. In addition to this inevitable increase of species thus encouraged, many others have been unwittingly imported from other countries, chiefly through the instrumentality of commerce with those countries; for it is a most significant fact that the worst weeds and the worst insect pests of American agriculture are importations from Europe. Thus, in addition to the undue increase of our native species, as above noted, we have to contend with these introduced foreigners, and it is no wonder that Dr. Fitch declared America to be the land of insects, for, as compared with Europe, we are truly bug-ridden.

As I have elsewhere stated (Encyclopædia Americana: Agricultural Entomology), "the losses occasioned by insects injurious to agriculture in the United States are, in the aggregate, enormous, and have been variously estimated at from \$300,000,000 to \$4,000,000,000 annually. It will never be possible to fully protect our crops from the ravages of the many species that injuriously affect them; but it is the aim of the economic entomologist to prevent as much of the loss as possible, and at the very least expense. To do so effectually, the chief knowledge required is of an entomological nature, *i. e.*, the full life history and habits of the different species; and this implies a great deal of close and accurate work in field and laboratory. By means of it we learn which species are beneficial and which injurious; and the ability to distinguish between friend and foe is of the first importance in coping with the latter, for it is a notorious fact that the farmer often does more harm than good by destroying the former in his blind efforts to save his crops. A great deal has been written and published of late years on the subject of economic entomology, much of it, however, at second hand; for unfortunately the original workers are few. That comparatively small progress has hitherto been made is due to this last fact as well as to the intricacies and complex nature of the subject. The economic entomologist, to do effectual work, must possess not merely a knowledge of the particular injurious species and its habits with which he wishes to deal, but must study its relations to wild plants as well as to the particular cultivated crops it affects. He must also study it in its relations to other animals. Indeed, its whole environment must be considered, especially in connection with the farmer's wants, the natural checks which surround it, and the methods of culture that most affect it. The habits of birds, the nature and development of minute parasitic organisms, such as fungi, the bearing of meteorology, must all be considered; and yet, with the knowledge that a study of all these bearings implies, he will frequently fail of practical results without experiment and mechanical ingenuity."

The earlier writers on applied entomology, as Peck, Harris, Fitch, Walsh, Le Baron, Glover, did good work in unraveling the life mysteries of injurious species, and framed their advice to the cultivator from these entomographic studies. Mere study of this kind alone, however, while essential, is not often productive of those important practical results which follow when it is combined with field work and experiment by competent persons and upon scientific principles. Many of the remedies proposed and recommended in the agricultural press are either ridiculous or else based on misleading empiricism, and economic entomology, as a science, is of comparatively recent date.

The time limit of this paper will permit but the briefest reference, by way of illustration, to some of the means alluded to. I have already indicated the prime importance of a knowledge of the entomography of the species to be dealt with, a knowledge that can come only by direct and careful inductive research carried on sometimes during many years, for every insect exists, in the course of its development, in four different states, three of them more or less abruptly marked by metamorphosis, and each with habit and environment peculiar to it. Thus the same species may inhabit earth, air, and water at one or the other period of life, and yet be quite incapable of a change of environment at any one period It took me five years, with a number of observers at command, to definitely settle some points in the entomography of the cotton worm (*Aletia xylina*, Say), and with all the resources of the French Government, its liberal premiam, its superior and sub-commission appointed for the purpose and at work for the past fifteen years, there is much that is yet mooted in reference to the grape *Phylloxera*. You have all heard of this insect, and perhaps a brief statement of its entomography will serve to illustrate the complicated problems with which the economic entomologist often has to deal. I quote in substance from one of my reports:

"The full life-history of the species exhibits to us no less than five different kinds of eggs: 1st, the regularly ovoid egg, 0·25 mm. long and half that in diameter, of the normal, agamic, and apterous female, as it is found upon the roots; 2d, the similar but somewhat smaller egg of the gall-inhabiting mother; 3d, the female egg from the winged mother, rather more elliptical, and 0·4 mm. long when mature; 4th, the male egg from same, one-fourth less in length and rather stouter; 5th, the impregnated egg just described, 0.32 mm. long, still more ellipsoidal, and with peculiar sculpture and anal point. We have also the peculiar spectacle of an egg from the winged mother increasing from 0·34 mm. (its size when laid) to 0·4 mm. (its size just before hatching), giving birth to a perfect insect 0·40 mm. long, and this without any nourishment, laying an egg 0·32 mm. long. A being thus born, and without food whatsoever, lays an egg very nearly as large as that from which she came.

"We have, further, the spectacle of an underground insect possessing the power of existence even when confined to its subterranean retreats. It spreads in the wingless state from vine to vine, and from vineyard to vineyard when these are adjacent, either through passages in the ground itself or over the surface; at the same time it is able in the winged condition to migrate to much more distant points."

The recent advance in our knowledge of the life-history and habits of species has been great, but leaves yet an immense field for future research.

Insects probably outnumber in species all other animals combined, some 350,000 having already been described, and fully as many more remaining yet to be characterized. The proper and conscientious characterization of a genus or species of some microscopic creature involves as much labor as that of one of the higher animals. Of the above number a goodly proportion are injurious to cultivated crops. Lintner recently records no less than 176 affecting the apple.

Of insecticides any number of substances have been recommended, and many of them tried with more or less satisfaction. Of these may be mentioned: lime, sulphur, soot, salt, wood-ashes, corrosive sublimate, naphtha, naphthaline, turpentine, alum, carbolic acid, phenyle, cyanide of potassium, blue vitriol, ammonia, alkalies, benzine, vinegar, sulphuric acid, quassia, vitriol (the sulphate of copper), hot water, etc. Most of these may be successfully used for specific purposes either dry, in liquid, or in vapor; but the three most useful insecticides of general application in use during the early days of economic entomology in this country and up to within a few years were undoubtedly tobacco, white hellebore, and soap. Tobacco water and tobacco smoke have long been employed against aphides and other delicate insects, and are most useful. A quite recent advance in its use is by vaporizing. The vapor of nicotine is most effectual in destroying insects wherever it can be confined, as in greenhouses. Thus the boiling of tobacco in such a greenhouse is as effectual as, and less injurious to the plants, than the older methods of syringing a decoction or of fumigation by burning; while experience by Mr. Wm. Saunders at the Department of Agriculture during the past two summers shows that the vapor gradually arising from tobacco stems strewn on the ground and regularly moistened is likewise effectual.

White hellebore, either dry or in liquid, has long been one of the most satisfactory insecticides against tenthredinid larvæ, otherwise known as false caterpillars, of which the important currant worm (*Nematus ventricosus*) is a familiar type; while soap, syringed in strong suds, will kill some soft-bodied plant destroyers, and when used as a paint on the trunks of trees is an excellent repellent against the parents of different borers.

Transcending in importance, however, any of these older insecticides are the three now most commonly used because most satisfactory. They are: (1st) arsenical compounds; (2) petroleum; and (3) pyrethrum. The first act through the stomach, and are effectual chiefly against mandibular insects; the second and third act by contact, and are therefore of more general application, affecting both mandibular and haustellate species.

The use of arsenic as an insecticide in the field dates from the year 1871. At the rate of 50 grains of arseniate of soda and 200 grains of dextrine dissolved in a gallon of water, and this diluted at the rate of about an ounce to ten gallons of water, it furnishes one of the cheapest of insecticides at command, and various patented combinations of it have been extensively sold and used. Again, 1 lb. of arsenic and 1 lb. of sal soda boiled in 1 gallon of water till the arsenic is dissolved, and diluted at the rate of 1 quart to 40 gallons of water, is also a good formula. The chief merits of arsenic are cheapness and solubility. Its demerits are its white color, which makes it liable to be mistaken for harmless substances of the same color, and its tendency to burn the plant. Paris green or Scheele's green has been more extensively used than any other arsenical compound, and is, on the whole, one of the most satisfactory insecticides. I first used this poison against the Colorado potato beetle (*Doryphora 10-lineata*) in the summer of 1868, but owing, doubtless, to the use of an inferior article, reported adversely upon it (1st Rep. on Insects of Mo. for 1868, p. 116). Geo. Liddle, Jr., of Fairplay, Wis., experimented with it the same summer, and with one part of the green to two of flour found it eminently satisfactory (*Am. Entomologist*, i., p. 219), and from the time he announced his experience, May 25, 1869, in the *Galena* (Ill.) *Gazette*, Paris green became rapidly popular against the doryphora. I first recommended it in 1872 for the cotton worm, and its use gradually extended to other leaf-eating insects until hundred of tons have been sold for insecticide purposes in a single year. It is used dry with various diluents, as ashes, plaster, flour, etc., at the rate of one part of the green (if pure) to 25 up to 100 parts of the diluent. Flour as a diluent has the great advantage of causing greater adhesiveness and permanence. In liquid suspension Paris green can be used at the rate of one pound to from 40 up to 100 gallons of water. The liquid should be kept constantly stirred, and a little dextrine or other substance added to give adhesiveness is an advantage.

A refuse obtained in the manufacture of aniline dyes, and known as "London purple," is the third important arsenical compound that I will mention in this connection. It consists of lime, arsenious acid, and carbonaceous matter, and was first used by me against the cotton worm and other insects in 1878, and more fully and thoroughly in 1879. It is used with diluents either wet or dry in the same manner as Paris green. While for some insects experience has shown it to be less satisfactory than Paris green, for many others it is equally effective, and has the great advantage over Paris green of being vastly cheaper (costing on an average but five cents against sixty cents per lb.), of covering twice the ground (weight for weight), of being more soluble, less poisonous, more adhesive and permanent in its effects, and of decided color, so that when intelligently used it is in all ways preferable.

Petroleum in its various forms has long been recognized as one of the most effective insecticides in our possession, all oily substances being particularly deadly to insects. Unfortunately, they are also injurious to plants, and one of the problems the solution of which I have had in mind for many years, has been their use in such dilution as to kill the insect without injury to the plant. Refined kerosene has been used to a limited degree, by forcible attenuation in water and spray, while some plants withstand doses of the pure oil. But the safe and general use of kerosene for the purpose under consideration dates from the year 1880. Of the various substances used in attempts to emulsify and mix kerosene with water, none are more satisfactory than soap and milk, both being everywhere accessible and cheap. Milk was first suggested in 1880 by Dr. W. S. Barnard while carrying on experiments for me against the cotton worm, and subsequent experiment, especially by another of my assistants, Mr. H. G. Hubbard, has given us the simplest and

* An address delivered before the Georgia State Agricultural Society at its annual meeting in Savannah, Feb. 12, 1884.

most satisfactory methods of making the emulsion quickly and permanently. An emulsion resembling butter can be produced in a few minutes by churning with a force pump two parts of kerosene and one part of sour milk in a pail. The liquids should be at about blood heat. This emulsion may be diluted with twelve or more parts of water to one part of emulsion, thoroughly mixed, and may be applied with the force pump, a spray nozzle, or with a strong garden syringe. The strength of the dilution must vary according to the nature of the insect to be dealt with as well as to the nature of the plant, but finely sprayed in twelve parts of the water to one of the emulsion it will kill most insects without injury to the plant. An equally good emulsion may be made as follows:

Kerosene................	2 gallons	=66⅔ per cent.
Common soap..........	½ pound	=33⅓ per cent.
Water	1 gallon	

Heat the mixture of soap and water, and add it boiling hot to the kerosene. Churn the mixture by means of a force pump and spray nozzle for five or ten minutes. The emulsion, if perfect, forms a cream, which thickens on cooling, and adheres without oiliness to the surface of glass. Dilute with cold water before using, to the extent which experience will indicate is best.

The simplest discoveries are often the most valuable, and this discovery of so simple and available a means of diluting, *ad libitum*, oil with water is important and far-reaching in its practical application. It were foolish to detain you with details of the several directions in which it has proved of great benefit, and which are recorded in my recent writings, especially in the reports of the entomologist of the Department of Agriculture for 1881–82 and 1883, and in Bulletins 1 and 2 of the Entomological Commission Division of that department.

Pyrethrum roseum, a plant native to the Asiatic countries south of the Caucasus Mountains, and *Pyrethrum cinerariæfolium*, a native of Dalmatia, have long been known to possess insecticide properties, especially in the powder from the dried and pulverized flowers. The powder sold under various names to druggists was chiefly used against household pests, however, and though Mr. C. Willemot as early as 1857 in France, and Mr. Wm. Saunders in 1879 in Canada, tried it in powder form on some that are injurious to plants, its importance as a field insecticide did not appear till in 1880, when, in prosecuting the work of the U. S. Entomological Commission, we discovered that it could be used in liquid solution. During the winter of 1880–81 I succeeded in importing a large quantity of the seed of both species, and on behalf of the above-named commission distributed it to a number of correspondents in various parts of the country with a view of establishing its cultivation. Since then large quantities have been distributed from the Department of Agriculture. Both species proved to be hardy throughout the greater portion of our country, and Mr. G. N. Milco, of Stockton, Cal., has for some years cultivated *cinerariæfolium* quite extensively at great profit, the product being sold under the name of "Buhach." The insecticide property dwells in a volatile oil. It acts only by contact, and its action on many larvae is marvelous, the smallest quantity in time paralyzing and ultimately killing. Its influence in the open air is evanescent, in which respect it is far inferior to the arsenical product; but being perfectly harmless to plants it can frequently be used on vegetables where the more poisonous substances would be dangerous. Pyrethrum is supposed to have no effect on the higher animals, but that is a mistake, as my own recent experience is that the fumes in a closed room have a toxic influence, intensifying sleep and inducing stupor, while the experience of Prof. A. Graham Bell with the powder copiously rubbed on to a dog, showed that the animal was made sick and was affected in the locomotive organs very much as insects are. The wonderful influence of this powder on insects has led me to believe that it might prove useful as a disinfectant against fevers and various contagious diseases by destroying the microzoa and other micro-organisms or germs which are believed to produce such diseases. It should be tried for that purpose. It is remarkable that these two plants of all the many known species of the genus should alone possess the insecticide property.

Of all insecticides to be used against root-feeding or hypogean insects, naphthaline, sulphocarbonate of potassium and bisulphide of carbon are the chief. Dr. Ernest Fischer in a recent work has shown that naphthaline in crystal may be satisfactorily used under ground, destroying by slow evaporation. But bisulphide of carbon still holds the first place in France against *Phylloxera vastatrix*. It is conveyed beneath the ground at the rate of ½ to 1 kilogramme per vine by special augers or more complicated machinery drawn by horses. I believe that petroleum emulsions will supersede it as an underground insecticide, and prove to be the best we have, cheapness, safety, and efficiency considered. This glance at the chief insecticides now in use may convey some idea of the recent progress in this direction, but will convey no idea of the far greater number of substances, whether drawn from the animal, vegetable, or mineral kingdoms, that have been experimented with and found wanting. After the discovery of a satisfactory insecticide, however, various important problems must be solved, and particularly how to apply it to greatest advantage, having safety to man and stock, harmlessness to plant, and economy in mind. The solution of these points, and others that the peculiar habits of the insect to be controlled involve, brings us to the question of mechanical contrivances and appliances; for while much ingenuity has been exhibited in devising mechanical means of directly destroying noxious insects without insecticides, it is chiefly in the proper application of these last that the greatest mechanical advances have been made both in this country and in Europe. Here again the subject is so vast that I cannot enter into details. One can form some idea of the recent activity in this direction by glancing at the figures in the first report of the United States Entomological Commission on the Rocky Mountain locust, my bulletin on the cotton worm, and other official publications. Perfection here, as in other kinds of mechanical appliances that aid man's progress in art and science, is usually the slow outgrowth of tedious trials. However brilliant the original theoretical conception, the practical details are almost always the result of sheer experiment and trial. Failures precede success. Yet success will usually follow in proportion as certain principles are kept in mind covering particular needs in special cases—principles deduced from entomological studies.

It will already have been gathered from what has preceded that the chief insecticides are applicable in liquid, and as liquids have an advantage over powders in field use, instruments for atomizing and distributing liquids constitute the most important part of insecticide machinery. The desiderata in a spray-nozzle are: ready regulation of the volume to be thrown; greatest atomizing power, with least tendency to clog; facility of cleansing or ready separation of its component parts; cheapness; simplicity; and adjustability to any angle. I will content myself with exhibiting one which meets perhaps more of these requirements than any other in use and which works on a new principle applicable to many other purposes than that for which it was designed,

It is what has been described and illustrated in my late official reports as the eddy or cyclone nozzle, and consists of a small circular chamber with two flat sides, one of them to be screwed on so as to be readily removed. Its principal feature consists in the inlet through which the liquid is forced, being bored tangentially through its wall, so as to cause a rapid whirling or centrifugal motion of the liquid, which issues in a funnel-shaped spray through a central outlet in the adjustable cap. The breadth or height, fineness or coarseness, of the spray depends on certain details in the proportions of the parts and especially of the central outlet. This nozzle originated at Selma, Ala., in the fall of 1880, while I was in the field with my assistant working at contrivances for the destruction of the cotton worm. In a discussion as to whether liquid forced tangentially into such a chamber would whirl or not, Dr. W. S. Barnard took the affirmative position, and experiment with a chamber improvised with two watch-crystals, in which the motion of the liquid could be observed proved the correctness of the theory. The final form of chamber adopted is the result of numberless experiments carried on by Dr. Barnard in my work both for the U. S. Entomological Commission and the Department of Agriculture, and the different phases of its development may be seen by the various models which I have brought for your inspection. Ladies and Gentlemen, I thank you for your attention.

AMONG THE CHINESE.

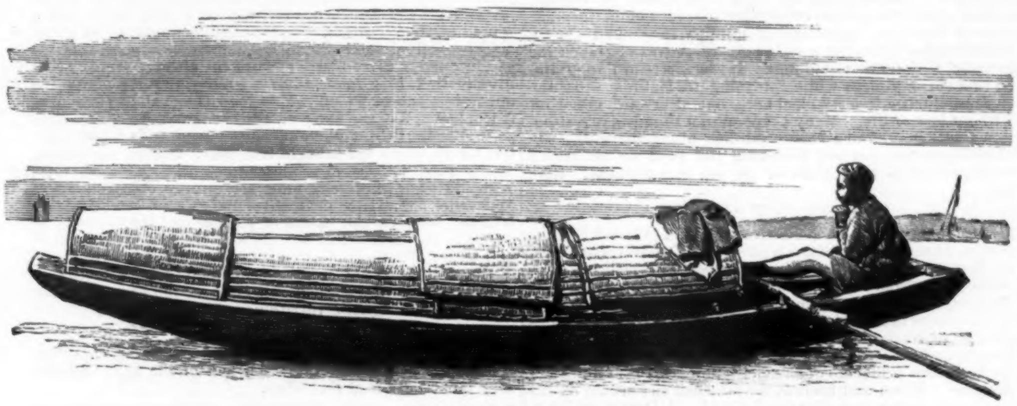
THE war in Tonquin has awakened the interest of Europe and America in China and its people. Very much is found

CHINESE PASSENGER WHEELBARROW.

CHINESE PASSENGER WHEELBARROW.

which is odd and peculiar, and all is interesting. In the annexed cuts, taken from *Ueber Land und Meer*, several scenes from China are shown.

The sampan is a Chinese boat used for transporting freight and passengers; as the cut fully illustrates it, no further description will be required. The express boat is built in a similar manner, but is longer and more slender, so as to give it greater speed. The wheel barrow cart, of which two cuts are shown, is used for transporting passengers; it is provided with a single central wheel, at each side of which an arm rest is arranged; at the front of the frame a footboard is arranged, against which both feet may be placed, or only the foot nearest the arm rest can be placed against the foot-board, the other foot being placed on a rope secured to the side of the vehicle. Males generally rest one foot on the rope, but females rest both feet against the foot-board. The vehicle is provided with two legs, like an ordinary wheelbarrow, and with two handles to which a strap is secured, which is passed over the shoulders of the person moving the vehicle.

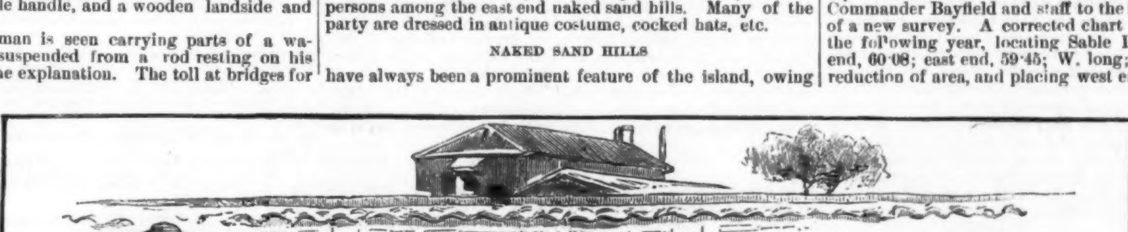


CHINESE EXPRESS BOAT.

THE SAMPAN.

The Chinese plow is a very crude implement; it has a wooden beam, a single handle, and a wooden landside and mouldboard.

Sometimes a Chinaman is seen carrying parts of a wagon or wheelbarrow suspended from a rod resting on his shoulder requires some explanation. The toll at bridges for wheelbarrows is eighteen cash, but a pedestrian or person carrying a load pays only four cash; to avoid paying this high toll, the person trundling a wheelbarrow takes it apart when he arrives at a bridge, hangs the several parts on the end of a pole, as shown in the cut, carries the wheelbarrow over the bridge, and then puts the parts together again, trundles his wheelbarrow along, and is made happy by having saved fourteen cash.



A CHINESE PLOW.

SABLE ISLAND—ITS RAPID SUBMERGENCE.

THIS island is situated about 60 miles S. E. of the coast of Nova Scotia, in latitude 44, longitude 60.

At a recent meeting of the Institute of Natural Science, Halifax, N. S., Simon D. MacDonald, F.G.S., read the following paper on "Sable Island—its changed position."

In my former paper on Sable Island, I introduced to your notice its general features, intending at some future time taking up and working out in detail some of its most remarkable points of interest. To-night I would call your attention to some of the many changes it has undergone which have materially altered its position. On the early charts of this coast, compiled from those of the French, and published 1775, this island is shown as occupying a position between 60·05 and 60·45 west longitude, 40 miles in length and about 2¼ in breadth. In 1779 a special survey of this island was ordered by the Admiralty, and the chart we have before us this evening was issued, together with numerous views of its appearance from different points of approach. Also a scene of what is evidently an encampment of shipwrecked persons among the east end naked sand hills. Many of the party are dressed in antique costume, cocked hats, etc.

NAKED SAND HILLS

have always been a prominent feature of the island, owing to the fantastic shapes they assume, and by their color being more readily seen in the distance. On a plan published by Mr. Darby, one of the superintendents, was a cone shaped drift marked "The Volcano," and said to be upward of 100 feet in height, situated at the west end, similar to one of those represented in the engraving. But the "Volcano" has been dispersed, and the position it occupied passed seaward many years ago and now lies fathoms deep. This survey appears to have been a very elaborate one, and well prepared; upward of 500-soundings are represented in the vicinity of the island and on the bank, and resulted in locating the island as follows: W. end 60·32, E. and 60·01. W. long; length 31 miles, breadth 2 miles, showing a decided decrease in area since previous observations, and placing the west end 22 miles further east. The next survey was that of the island proper in 1808, ordered by General Sir George Prevost, then governor of this province, who, moved by the terrible circumstances attending the

LOSS OF THE TROOPSHIP PRINCESS AMELIA,

made every effort to induce the British government to erect or aid in the erection of a lighthouse on the island. Lieut. Burton, of the Fusiliers, then stationed at Halifax, was dispatched to report on the feasibility of erecting a lighthouse and to inquire into the wants of the island. From his report we learn the island was 30 miles in length, 2 miles in breadth, with hills from 150 to 200 feet high, beginning at the west end and attaining their greatest elevation at Mount Knight at its eastern extremity. Just a few words here with regard to the first chart: It may be thought by some that little dependence should be placed on a chart compiled at a time when so little was known of the coast. But we have only to remember that the island was known to the French as early as 1598, and that 40 years previous to the publishing of this chart

THE WALLED CITY OF LOUISBURG,

had reached the zenith of it prosperity, with its magnificent fortresses, which were 30 years in building at a cost of $5,500,000, the station of a powerful French fleet, which for armament and numbers has never been seen in North American waters since, and a city whose commerce was of no little importance. That then, as now, in early spring time, the Gulf of St. Lawerence current brought its fields of ice blockading the south shores of Cape Breton, to avoid which those cruisers and merchantmen bound for the harbor of Louisburg were compelled to run south and westward, making an off shore approach which would throw them into the immediate vicinity of this island. Furthermore, on two occasions, a British besieging squadron lay before that city and cruised off its shores, the strength of which can be estimated when we learn that 140 sail, 36 of which were frigates and ships of the line, left Halifax for Louisburg in a single day. All this seems to warrant the conclusion that the knowledge possessed in early times of the coast and this adjacent island was even greater than ours of to-day; and it is difficult indeed to give a satisfactory explanation of the variation in these charts unless we attribute it to the actual changes undergone. But let us proceed. In 1850 the late Hon. Joseph Howe visited this place as commissioner for the purpose of making himself personally acquainted with the island and its requirements. In his report he called the attention of Parliament to the rather startling fact that by actual measurement

THE ISLAND HAD DECREASED ELEVEN MILES

in the last thirty years at the west end, and further, that for the safety of navigation and the prevention of disasters their first duty with regard to Sable Island was to have its position defined; that while in the cabin of the Daring before him lay a chart by which that vessel was supposed to be navigated, also another compiled from observations made by the superintendent, Dapt. Darby, in 1829, the discrepancy between which and its possible effect on navigation was appalling to contemplate. It was as follows:

Admiralty chart, W. End, 60·32 W. Long.
E. End, 60·03
Capt. Darby's chart, W. End, 60·10
E. End, 59·48

Difference, 22 miles.

This chart on board the Daring appears to have been one issued between 1810 and 1820, in which the island is laid down as being 29 miles in length. On the strength of Mr. Howe's report the admiral was communicated with, who ordered Commander Bayfield and staff to the island for the purpose of a new survey. A corrected chart was issued by Bayfield the following year, locating Sable Island as follows: west end, 60·08; east end, 59·45; W. long; showing a still further reduction of area, and placing west end two miles still farther eastward than shown by Darby in 1829. Surprising as this evidence of change may appear, it is fully borne out by the testimony of all those whom fortune has led in the interest of humanity to dwell upon its shores. The position chosen for the main station in 1802 was one remarkably sheltered among the sand hummocks, at a distance of five miles from the west end. In 1814, the superintendent, Mr. Hodson, wrote the government "that,

OWING TO THE RAPID MANNER IN WHICH THE ISLAND WAS BEING WASHED AWAY,

it would be necessary for him to remove the establishment to a more secure position. That within the four years previous 4 miles had gone entirely from the west end, leaving but one mile between him and the sea, which was advancing steadily, while on the north side an area equal to 40 feet wide and 3 miles long had been carried away during a single gale the previous winter. He therefore proposed moving the buildings to a place called Middle Houses, 3 miles farther east. In 1820 this superintendent again wrote that not only had the old site of the main station gone seaward, but that the sea was again encroaching to such an alarming extent that he would be obliged to once more remove the station, and had selected a place known as the Haulover, 4 miles farther east. Again the sea advanced. The two following winters were noted for the frequency of storms and the havoc made along the cliffs, every gale sensibly diminishing the western portion of the island,

TOPPLING GREAT MASSES OF SAND HILLS INTO THE SURF,

as well as altering the surface in the interior, as in the instance mentioned in my last paper, when thousands of tons of sand were carried from the beach and strewn over the island, smothering vegetation so that hundreds of horses died for want of food. Seeing the necessity of securing more permanency for the main station, and the building from being so often removed becoming dilapidated, the present position was selected on the broadest and most protected portion of the island, and new buildings erected in 1833. The old dwelling of the superintendent was removed for the third time, now to be used as a house of refuge another 4 miles eastward. Here it enjoyed short respite, when again the sea threatened its foundation. This marks the 11 mile point spoken of in Mr. Howe's report. Now, all this seems so much like romance that were it not for the authenticity given it by parliamentary reports as well as by the records of the island I should hesitate in giving currency to these statements. But what of this house of refuge? Is it still moving? No! it has found a grave. For the fourth time it was moved—the last time 2 miles farther east. Gradually the gales removed the hummocks that sheltered it. Left to the rake of the winds,

SAND LADEN EDDIES SWIRLED ABOUT IT;

slowly a mound arose until the house disappeared from sight and the surface became leveled out, leaving nothing above by which its position could be indicated. A short respite, and again it must open up to view, be bared to its foundation or be thrown down with the embankment and floated away in the breakers. Between the years 1850 and 1862, this western extremity of the island appears to have enjoyed a period of comparative repose. This may be accounted for by the fact that so much material was thrown down, a shoal was found to the west on which the seas would probably break before reaching the sand bluffs and thus lose their abrading force. In the same manner the main body of the island is defended by three parallel bars, which act as a barrier reef and protect or at least retard the word of destruction, which would otherwise proceed with great activity. On the removal of this shoal by the current, the seas began again to manifest their force. The winter of 1881 was remarkably stormy, gale succeeding gale in quick succession. In addition to the gradual work of erosion, great areas were removed bodily. During one gale 70 feet by ¼ of a mile departed. A month later 30 feet of the whole breadth of the island at the west disappeared in a few hours.

THE WINTER OF 1882 WAS EVEN WORSE.

than the preceding one, and was noted for the destruction wrought among the buildings, including the west end light house, a magnificent structure, erected in 1873, one mile inside the grass hills. Early in February of that year, a gale of unusual violence visited the island, accompanied by very high tides. Already the sea had removed the embankment to within 40 feet of the bluff on which the light keeper's barn stood, and was now within dangerous proximity to the lighthouse. As the tide rose the gale increased; all hands were now out ready for any emergencies that might require their presence. The cattle had been removed to the porch of the lighthouse, and the staff were watching the force of the waves that were now undermining the embankment with great rapidity. Suddenly a depression along the cliff gave warning of a downfall. The next moment an area equal to 48 feet broad and a quarter of a mile long descended into the breakers on the north side, while during the night the 40 feet in front of the barn also departed, and next morning the barn itself went crashing down the declivity, and was swiftly borne away by the current.

THE STORMS THAT PRODUCE THE MOST DESTRUCTION?

are those from the S. E., bringing in heavy seas which, striking obliquely on the south shores, aided by the powerful current setting to the west, erode the sand cliffs, until large masses are detached, fall into the current, and are carried forward. This helps to prolong the N. W. bar. Again, during calm weather, when wind and waves are still, the shores and bars are white with foam from the ever present ground swell, which makes landing so precarious that it is seldom attempted except by the serf boat at the stations. In the loss of the west end lighthouse we have a remarkable instance of the wasting force of the swell. The weather had been unusually quiet for the space of two days, during which a heavy ground swell hove in from the S. E. (probably from a storm passing along the Gulf Stream), which carried away the remaining twelve feet of embankment in front of the lighthouse, causing it to lean dangerously forward, and necessitated the hasty removal of the apparatus, from which time the light ceased to send its warning across the wave. Although changes are more observable along the bluffs, yet the beach itself is continually varying in form, increasing and diminishing in particular parts. In this way

OLD WRECKS ARE BROUGHT TO THE SURFACE,

and others concealed during a single gale. Some years ago there was discovered after a gale spars, canvas huts, etc., showing a prolonged stay, of which there is no record. This spot has also passed under the sea. In 1837 Mr. Miller, the third commissioner appointed to inquire into the possibility of erecting a lighthouse, reported that on visiting the island he found the position chosen by him in 1833 had undergone a complete change. And the site selected by a former commissioner favorable to the project had been completely remove by the high winds that have at times such effect in causing remarkable changes in the interior as well as on the shores of the island; he would only feel justified in recommending a temporary erection, such as could be easily removed to a more secure position when necessity required it. We can readily see how hills of loose sand thrown up by the winds into every fantastic shape that snow drifts can assume, like those drifts are ever changing their extent and position. The removal of those sand drifts or dunes has brought to light some interesting historical facts. In 1842 during a severe gale an old land mark in the form of a pyramid near the W. end station was completely blown away, exposing to view several small houses built from the timber of a vessel. On examination they were found to contain quite a number of articles of furniture, stores put up in boxes, bales of blankets, quantities of military shoes, and among other articles a brass dog collar on which was engraved the name of Major Elliot, 43d regt. It was afterward ascertained that this regiment while returning to Halifax after the siege of Quebec was wrecked here, but afterward taken off without loss of life. Many years ago a roundsman's attention was attracted to a blackened line along the cliff. On climbing to the spot and removing the sand he uncovered what proved to be the site of an old encampment. Here lay

RUSTY BAYONETS AND GUNS

knives made of iron hoops, broken glass, a tattered English ensign, human bones mixed with those of cattle and seals, an English shilling of the reign of Queen Elizabeth, sharp as when taken from the mint, which furnished the date of the disaster, but nothing further left to give the clew to the sufferers except that they were Englishmen. Thus the gales are also ever bringing to view evidences of calamity of which history and tradition are equally silent. Turning to the lake we find more evidences of the vicissitudes this island has undergone. When first known, the lake had an opening on the north side which was afterward closed. A few years later, during a terrific storm, the seas forced a channel through the lake margin on the south side, rendering it a convenient harbor for small vessels. But in 1836, a similar tempest closed it again, shutting in two American vessels that had run in for shelter on seeing the storm approaching. Gradually it became very shoal from the material drifted into it and the washing of the cliffs. But by being dammed up by the closing of the inlet and filled by the surf washing across the ridge, it afforded great facility for forwarding the life boat in case of a wreck, and the transport of wrecked materials to the main station for shipment. During the winter of 1881 a severe gale opened a gulch toward the east end, so draining it as to reduce it to only 8 miles in length, and rendering it useless as a means of transport. The lake margin forming the south shore in like manner testifies to the destructive agency of the sea, having a breadth at one time of half a mile, with sand hills of upward of 50 feet in height. At present it is merely a narrow ridge, forming a precarious sea wall, over which the waves now break in stormy weather. Should this inner barrier be removed,

THE WORK OF THE DEMOLITION OF THE ISLAND

will go forward with increased rapidity. During storms, in addition to the action of waves and currents, the winds independently ravage its surface. Finding a raw spot, as it is termed, the eddying winds scoop out the loose sand, when not confined by the grass roots, into bowl like depressions, which afterward form the fresh water ponds so often found in the interior, while around the stations it requires the utmost vigilance of the men to watch the first break in the sod and repair before headway is gained, otherwise the buildings would soon go from their foundations. While the wind and waves have been so active in modeling and remodeling the island proper, currents and eddies have also been at work on its submerged portion, although from the difficulties attending observation we are not so cognizant of the various changes taking place. One, however, fraught with much danger is making itself manifest to a painful degree. That is the prolonging of the N. E. bar. By reference to this wreck chart it will be seen that most of the wrecks of late years have occurred here, one of them as much as 16 miles from the light. The changing character of the N. W. bar at the other extremity of the island may be inferred from an extract of Capt. Darby's report in Blunt's Coast Pilot of 1832 as follows: "I have known this island for 27 years, during which time the west end of the island has diminished seven miles in length, although the outer breakers of the N. W. bar have the same bearings from the west end of the island as they formerly had, clearly showing that the whole bank and bar are traveling eastward." With regard to the island having traveled the entire distance shown on those charts, it would be hazardous to adopt such a conclusion, yet it is certain

ITS PROGRESS EASTWARD

is in keeping with the natural tendency of all sand accumulations. Although this material may be carried sometimes one way and sometimes another, yet nevertheless its progress must still be in the direction of the prevailing winds. In some parts of the world, in consequence of the preponderance of certain strong winds in one direction, such accumulations make a regular progressive movement, and have buried farms, houses, cities, and whole tracts of country, of which there are numerous instances on the English and French coasts. At this island the strong west wind is as constant as a trade wind, and its material is being continually borne before it. In this way the amount drifted from west to east must have been enormous, and may account to a great degree for the diminished height of the island. At the same time I think we are safe in concluding that while this island has traversed a certain portion of this distance, its changed position, as here indicated by those admiralty surveys, is mostly due to submergence. Of course an island so constituted, exposed to the unobstructed violence of the whole Atlantic, could not long resist the terribly destructive action of the breakers, aided by swift currents and the denuding agency of wind and rain. Already we have seen that within a comparatively short space of time, dating back but a few years previous to the formation of this life saving station, it has decreased in length from 40 miles to 22; in breadth from 2¼ miles to something less than one mile; in height from 200 feet, as given in 1808, to 80 feet, according to last observations. The future of this island to the navigator is everything but cheering. And should the destructive forces now in operation continue, we can easily calculate on a period, and not a very remote one, when the sea will claim it as its own.

A FLORIST in Chambersburg has a remarkable rose bush. During the last three years, and including the present time, over 10,000 buds were plucked from its numerous branches. Some idea may be had of the value of this vine when we state that these buds sold during the winter at $15 a hundred. At this time not less than 2,000 buds can be counted on the vine. It is believed that it is the largest vine in the United States.

STUDIES OF THE AURORA.

TRESCA gave a flattering testimonial to the ingenuity and success of Prof. Lemström, on laying before the French Academy the results of the experiments in Lapland for producing artificial auroras. He considers that Lemström has demonstrated, by those experiments, that in extreme northern latitudes, and at a temperature of —30° (—22° F.), the polar aurora is an electric phenomenon, which may be represented by atmospheric currents of a magnitude corresponding to a current which would be produced by a Leclanche cell of moderate size. The natural manifestation of this current gives place, even in the absence of any other illumination, to a local aurora, which is visible above the apparatus, and in which can be seen the characteristic line, $\lambda = 5,569$. We are thus able to recognize, with complete certainty, the existence, and even the magnitude, of the electric forces which are brought into play. During the coming winter Prof. Lemstrom proposes to continue his researches, with the view of determining the proper construction of apparatus for giving currents of the greatest intensity; the relation between the extent of surface and the intensity of current; the variation of current with differences of latitude and with differences of altitude between the two extremities of the apparatus; the influence of the seasons; and the relations between the atmospheric current, the terrestrial current, and the magnetic variations.—*Comptes Rendus.*

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